AGRICULTURAL ENGINEERING

FEBRUARY · 1946

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Building Ponds

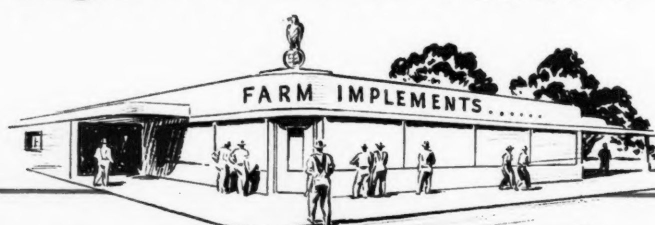
Most amazing among modern Soil and Water Conservation practices is the swift rise to popularity of farm ponds. Perhaps this is because ponds are good for recreational values as well as for farming—because they furnish not only water for livestock, irrigation and fire protection, but also a place for fishing, swimming and skating.

Designing a farm pond is definitely a job for the conservation engineer. Building the pond to his specifications is just another job for a modern farmer with his own tractor and plow, plus a rented or borrowed scraper. Helping with the fine points of pond-building with farm machinery is another opportunity for the Case dealer.

"Build a Pond" is another in the series of educational booklets offered by Case to encourage and assist farmers in the adoption of advanced farm practices. More than a score of colorful photographs, supplemented by simple drawings and diagrams, show every step from start of survey to completed pond.

Whatever may be the advanced practices suited to your territory, there are Case machines for their application. Case movies and booklets inspire action and give instruction. Like Case advertising in the farm papers, they all point to the Case dealer as the source of counsel, equipment and service. All are at work to put him in first-line position for the period of aggressive selling that lies ahead. J. I. Case Co., Racine, Wis.

Points Right to Your Place . . . . .



CASE ★ ★

HEADQUARTERS FOR ADVANCED FARM PRACTICES

Addressed to farm equipment dealers, this message is one of a series pointing out the part they play in soil conservation, to the benefit of themselves and their customers. Related advertising in farm papers urges farmers to regard their Case dealers as headquarters for practical counsel on the power and machinery aspect of soil conservation and other advanced practices.

"Hope they grow faster than her last litter,"

SAID HENRY LENT

"They will if they eat right,"

SAID THE COUNTY AGENT

Henry Lent had always raised a few hogs so his family could have all the home-killed meat they needed.

But he didn't go into hog raising on a big scale until two years ago.

Last Spring the County Agricultural Agent dropped by Henry Lent's place when the sows were farrowing, and they talked hogs while they looked over the new litters.

Henry told the County Agent that he wasn't too pleased with the showing he'd made with hogs the year before.

"It took me a long time to get them heavy enough for market," Henry said. "And it wasn't because I didn't shove the feed into them, either. They just didn't fill out." And then he told the County Agent all about his feeding program the year before.

"That sounds about right to me," the County Agent said, "except I don't believe your hogs are getting the salt they need to really put on weight. They've got to have minerals as well as fats and proteins to get up and grow."

So the only change Henry Lent made in feeding his hogs last year was putting salt in the hog lot, so his shoats could get all they wanted.

And the few cents he invested in salt, at the County Agent's suggestion, paid off plenty! Last fall, when he sold his hogs, they averaged 76 pounds heavier per head than they had the year before.

"It's a good thing to have plenty of salt in the lot if you want your pigs to hurry to market," the County Agent said, when Henry Lent dropped by to show him his hog check.

"And the County Agent's a handy man to have around when you want well-seasoned advice about farming," said Henry Lent.

All over the country, farmers are getting help from their County Agents that makes farming *better* and *easier*.

Another thing that good farmers are doing to farm better and easier is to make full use of electricity.

WORK WITH YOUR COUNTY AGENT

- Attend the meetings and demonstrations he holds in your neighborhood.
- Take advantage of the free literature on farm problems that he has or can get for you.
- Help save his time these busy days by talking with him by telephone, instead of asking him to make a special trip.

YOU'RE SURE TO GET BETTER HAY WHEN YOU CURE IT IN THE BARN

Farmers who have installed barn hay-curing systems report these advantages:

1. You can make good hay in almost any kind of weather. All you need is a little time between showers to cut hay and allow it to partly cure.
2. You get hay worth from five to ten dollars more a ton, whether you sell it or feed it. Barn-cured hay doesn't lose its leaves (and its feeding value) because it has a high moisture content when it's put into the barn. It has a better color and is a more palatable feed.
3. With plenty of high-quality barn-cured hay, you'll need to feed your stock less grain and costly concentrates.
4. There is less of a fire hazard in storing barn-cured hay. The hay is cooled as it is cured by the air circulating through it.

Now's the time to plan your barn hay-curing system, to have it ready for next haying season. G-E's FREE booklet on barn hay-curing will help you plan yours. Write for your copy today, to General Electric Company, Apparatus Dept., Sec. 669-24, Schenectady 5, N. Y.

The Modern Farm is an Electric Farm!

Electricity on the farm can make life more pleasant and work easier.

If you don't have electricity, get in touch with the electric service supplier in your area.

If you already have electricity, get your full value out of it by making it do more jobs for you.

To help build up modern farms electrically continues to be the full-time job of a staff of farm specialists in the G-E Farm Industry Division.

G-E STOCK TANK DE-ICER KEEPS HOLE IN ICE SO STOCK CAN DRINK

This winter many farmers have reported that their G-E stock tank de-icers are giving excellent results in maintaining a hole in the ice of outdoor tanks.

This new device, with its built-in, automatic control, provides access to drinking water for cattle, sheep, and hogs—no matter how cold it gets. It floats freely in the tank, prevents ice from forming on the surface near the de-icer. Stock merely push it down to drink.

MORE POWER TO THE AMERICAN FARMER

GENERAL ELECTRIC

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AGRICULTURAL ENGINEERING

Established 1920

CONTENTS FOR FEBRUARY, 1946

Vol. 27, No. 2

This Journal is owned, edited, and published monthly by the American Society of Agricultural Engineers.

Editorial and advertising departments at the executive office of the Society, Saint Joseph, Michigan. Publication office at Benton Harbor, Michigan.

The A.S.A.E. is a member of

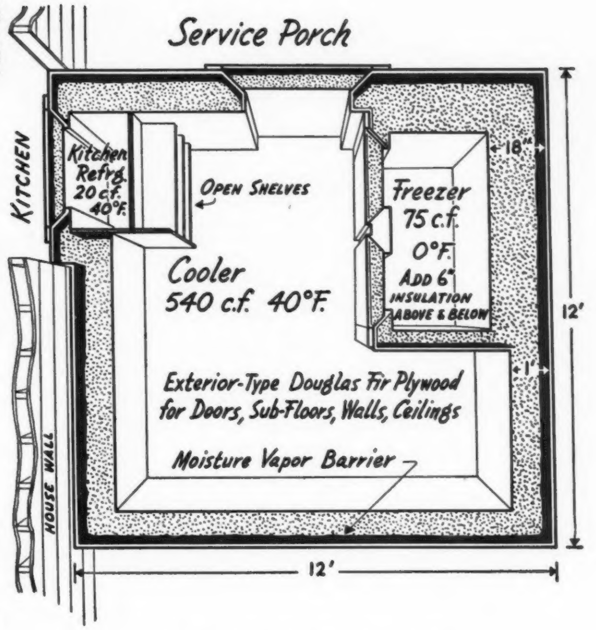
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AUDIT BUREAU OF CIRCULATIONS

SUBSCRIPTION PRICE: $3.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

Sketch shows Farm Home Food Refrigeration Center, including kitchen refrigerator (50° F.), cold room (40° F.), and frozen food cabinet (0° F.), operated with one mechanical refrigeration plant.



Farm Home Food Refrigeration Center

— constructed with Douglas Fir Plywood

Farm families producing and storing a large part of their food will be interested in this "food refrigeration center", based on Washington State College Extension Bulletin 317—"Home-Built Farm Refrigerators". Situated adjacent to the kitchen—and on the same floor level—it permits construction of a conventional wall-type domestic refrigerator, cooler and freezer room in one. Low construction costs are indicated by the sketch and specifications, and by the fact that the refrigeration machinery is concentrated in a single unit. Economical operation and maintenance are achieved by proper selection and installation of construction materials. One agricultural engineer with several years refrigeration experience states that leakage from the freezer should maintain cooler and refrigerator temperatures except for the summer period. No evaporator coils or plates need be installed in the refrigerator.

Plywood panels constitute an excellent construction material. They are durable and can be installed easily. Fewer cracks and joints reduce air infiltration. Low thermal conductivity provides an effective vapor barrier.

The insulation suggested (dry wood shavings) is optional, but has been shown to indicate wall design required. If commercial insulation is used, an 8-inch outer wall, floor and ceiling thickness is recommended on the freezer, 6-inch on other exterior surfaces. All doors should carry an adequate vapor seal and 4 inches of commercial insulation.

DOUGLAS FIR PLYWOOD
LARGE, LIGHT, STRONG.
Real Wood PANELS

Douglas Fir Plywood Association
Tacoma 2, Washington

Construction Suggestions

FLOOR: Joists 2" x 8", spaced 16" o.c., with 2" x 4" 's on 12" centers on edge across them. Tack moisture-vapor-proof paper which is odorless and tough enough to resist tearing lengthwise and to the underside of the 2" x 8" joists. Tarred or asphalted felts are not satisfactory. Coat all lapped edges of paper to seal joint and allow 6" overhang on all sides to fold up and seal to similar paper in walls. Coat 3/8" EXTERIOR Douglas fir plywood panels, both sides and edges, with two coats odorless asphalt or aluminum paint. Nail lengthwise and beneath joists with 6d galvanized nails spaced 4" o.c. Where panel cross joints occur cut 2" x 4" header between joists and inside vapor seal for nailing ends of panels. Fill to top of 2" x 4"'s with loose fill insulation. Cut 1/2" EXTERIOR Douglas fir plywood panels to inside wall line, lay across joists and nail for subfloor. When box is completed cover exposed floor area with linoleum cemented in place.

Thickness of insulation indicated in sketch and framing specifications is intended for dry wood shavings. If commercial insulation is installed the thickness indicated in text should be used and the framing modified accordingly.

WALLS AND CEILING: Erect two rows of 2" x 3" studs 16" o.c. for inside and outside walls, and lay ceiling joists similar to floor joists. Over outside studding (or against house wall) place moisture-vapor-proof paper vertically, cementing all joints including joint with paper turned up from floor. Allow paper to protrude 6" above top of box to cement to ceiling barrier.

Nail 3/8" EXTERIOR Douglas fir plywood panels to underside of ceiling joists and vertically on both inner and outer studding, using 6d. galvanized nails 6" o.c. Both sides and edges of panels for outer walls should be painted with two coats of exterior type aluminum paint. Fill all wall and ceiling cavities with insulation. Tack vapor proof paper to top of ceiling joists and cement all joints. Lay plywood panels on top to prevent puncturing paper; after one or two years, holes may be cut in ceiling paper barrier, additional insulation added to compensate for settlement in wall cavities, and paper patches cemented over cut-outs. The insulation is continuous from ceiling through walls to floor.

REFRIGERATOR AND FREEZER: Construct in place against inside walls, continuous from floor to ceiling. Install insulated cabinet doors and shelves in both as desired. Open storage shelves in cooler space optional.

DOORS: Jambs and doors require careful manufacture and fitting. Jambs should be accurately milled, allowing space for a compression seal stripping for the door contact, and should be firmly fastened to the rough frame. The vapor barrier should be continuous behind jamb and cemented to inner edge of rough frame.

Doors should have 1/2" EXTERIOR Douglas fir plywood panel glued and nailed to outer face of 4" thick milled frame. Paint inside surface with two coats of aluminum paint, fill door cavity with 4" of commercial insulation and nail and glue 3/8" EXTERIOR Douglas fir plywood panel in place of inside face. Where compression gasket tacked on door frame cannot be continuous across threshold install felt strip on bottom of door to seal crack.

ROOF: Extend porch roof to cover box.

PAINTING: All interior wall and ceiling surfaces may be painted with shellac and varnish in two coats. All exterior walls may be given finish coats of aluminum or other exterior paints.

HARDWARE: Heavy-duty, galvanized or chromium plated refrigerator-type door hardware should be installed.

NOTE: It is essential that the mechanic constructing a freezer or cooler box understand that the moisture vapor barrier must be continuous around all exterior surfaces to avoid moisture penetration from the atmosphere to condense and freeze within the insulation space. The paper suggested here must be carefully installed to insure all laps being cemented and no breaks or tears. No barrier is to be installed against the inside, or cold, wall.

EDITORIAL

The Challenge of Today*

By J. Dewey Long

President, American Society of Agricultural Engineers

THE successful ending of the war has brought us, the members of the American Society of Agricultural Engineers, new opportunities and responsibilities, both as individuals and as a technical society.

It is timely that we should consider our developments of the past few years and the probable service we shall have an opportunity to render during the immediate years ahead.

A first consideration for any technical group is that war developments and training have accelerated the mechanism of our nation. This is no less true in farm machines and in prefabricated houses than in industry and aviation. We are to see changes in our planning and design based, let us hope, on the best of the past with the addition of the most productive new discoveries and thinking.

Changes in our social and industrial structure may be advocated. Our international relationships are certain to be the source of much debate. As men qualified to speak for one phase of our nation's technical progress and well-being, we must become informed of the sociological implications of the work we accomplish. We must be prepared to take our place with other technologists, and exert our leadership in our sphere of influence to help accomplish "the greatest good to the greatest number." International relationships built soundly on technical service, understanding, and respect are the strongest bonds between nations.

In our domestic relationships agricultural engineers have developed an enviable position in the eyes of farm people and the industry they serve. We do not need a public relations campaign to assure our continued good will, but we can be more aggressive in seeing that engineering thinking and planning takes its proper place in farm programs whether they be federal, state or individual.

In common with most technical men, agricultural engineers as a class are employees rather than employers. We are not concerned directly with the responsibility of the management-labor problems of industry. Without entering upon controversial grounds, however, we can do our part to maintain and improve our American way of life. We can see to it that our subordinates are fully informed of our goals and ambitions in the work they are asked to accomplish toward the continued prosperity and attractiveness of farm life. We can make certain that our executives and administrators are fully aware of the responsibility in their decisions for our services and agricultural contacts. By so doing we shall help develop a higher morale among our co-workers and merit an even greater appreciation for our services and products from our clientele.

War shortages as well as war developments have focused attention on agricultural engineering problems. Labor-saving is an old subject with us, and one in which we shall never achieve the ultimate goal. But economy in man-hours or energy expended is not enough. We must translate this into greater over-all accomplishments and productivity, and into opportunities for a high standard of living. Power and material shortages remind us that our natural resources are not inexhaustible, and that we must secure a greater duty in their use on the farm. Food shortages will not soon be forgotten; we must carry a heavy responsibility for the generation in securing ample production, wasteless storage and economical primary processing. For both this and future generations we carry a major responsibility in the conservation and improvement of our soil resources.

We have the opportunity by our research, production and teaching to improve the welfare of our farmer constituency and of our nation. We must accomplish this if they are to hold their respective positions in this competitive civilization.

It is significant that the program of this meeting deals with current activities and future plans of our profession, and brings before us the largest group of our leaders who have ever spoken before a general meeting of our Society.

*Introductory remarks at the opening session of the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 7, 1945.

Salute to the Schoolmaster

FROM an exchange of personal correspondence between active members of the American Society of Agricultural Engineers, each a member for well over a quarter-century, we purloin the following paragraphs. Perhaps it is well that we have not sought permission to quote by name and that the substance be set forth without the prestige of personality.

"In ye good old days I clung to the idea that it was my job to pull students up to college level and acted accordingly with great firmness and personal enthusiasm. Today there is reason to believe that greater prestige occurs if we lower the college to the student and refrain from meddling with his level. I used to think that teaching sound doctrine and striving towards classroom excellence was the course and goal for those entrusted with instruction.

"But today it looks as if the fellow who does some researching and issues some writings, even though he lets classroom minutes go hang, is Administration's fair-haired boy. When some ardent doctor expresses himself as terribly bored by the fact that he has a class in some subject or other, it is taken as a sure sign that he is a profound thinker and investigator and he is advanced and relieved accordingly. Yes, effective teaching is wholly intangible."

We should confess that as a professional society, and in this its journal, we have directed our attention and our honors largely to the activities and the persons whereby the technical frontiers of agricultural engineering are pushed steadily forward. In this there is nothing wrong, but we have too much neglected the schoolmaster who weaves these technical achievements into everyday education, and at the same time inspires the researchers of the decades to come.

As the branch of engineering closest to biology, we should be well aware that a profession, like a species, is fit to survive and flourish only if its qualifications include that of vigorous reproduction. The schoolmasters among us are our reproductive system, and should be recognized accordingly. Indeed, we may properly bear in mind the easily observed biological principle that genius tends to be sterile. The more brilliant the discoveries of the researcher, the greater becomes the burden on the educator to put those discoveries into general knowledge and usefulness.

What with the return of veterans seeking renewed education, the crowding of the universities, the degeneracy of education into mere training under the pressures of war, to mention only a few current problems, this is a critical time for education and educators. Others of our profession may well give more conscious honor and support to our schoolmasters.

AGRICULTURAL ENGINEERING

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Electric Ventilation of Poultry Houses

By George W. Kable

MEMBER A.S.A.E.

THERE were in the United States, at the time of the 1940 census, 1,093,875 flocks of 100 or more laying hens. The distribution of these flocks is indicated in Table 1. The total number has probably increased considerably during the war. In addition, within the past decade the number of farms having high-line electric service has increased from around 744,000 to 2,700,000, with prospects the number will reach 4,000,000 within two or three years. It is a reasonable assumption that these farms with electric service include a million of those having flocks of more than 100 birds.

With a large percentage of the flocks of over 100 located in northern states where winter ventilation is a problem, and with electricity offering a possible practical solution, it is time that serious thought be given to the subject.

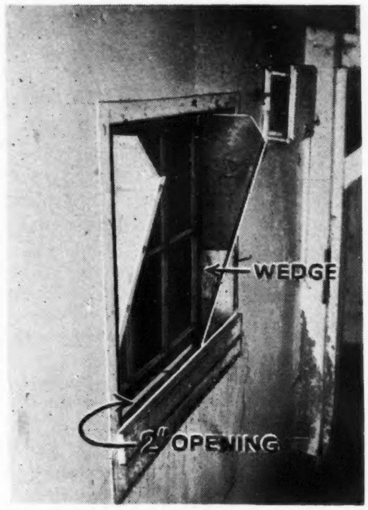


Fig. 1 Tip-in window in LaValle poultry house showing 2-in opening at the bottom

Present Development of Electric Ventilation. A number of poultrymen have installed fan ventilation systems. Where the system was designed to the best of our present knowledge, the poultrymen have been well pleased with results.

Last summer I visited the Poultry Tribune experimental farm at Mount Morris, Illinois. A 12-in, 1/16-hp fan had been installed in one end of a 30x36-ft laying house with a discharge flue running down to exhaust the air from near the floor level. Tip-in windows, opened a small amount, were used for intakes. A thermostat was provided to turn off the fan when the house temperature dropped to 32 F (degrees Fahrenheit). The house was insulated. In the climate of northern Illinois, the fan seldom stopped in the winter time. The system apparently gave very good results.

Several poultry farm installations have been made in central New York under the supervision of Lyman H. Hammond of the New York State Gas and Electric Co. One of these is on the farm of Lee LaValle of Memphis, N. Y.

The LaValle house is a converted barn with pens on three floors. A gravity ventilation system, which had the personal attention of the manufacturer's engineers and was rebuilt several times under their direction, had failed to provide satisfactory ventilation. The outtake problem was solved by providing 12-in fans driven by 1/20-hp, split-phase, totally enclosed motors. One fan was installed in each pen of 550 hens with the outtake flue opening about 16 in up from the floor. The gravity system intakes were used, supplemented by tip-in windows which were not tipped in but were sawed off and wedged in place to allow for a 2-in opening at the bottom (Fig. 1). These openings were baffled to direct incoming air upward.

After some experimenting to get the intakes and exhaust fans properly located, the system has worked very satisfactorily. The fans run continuously 24 hr per day all winter. On very cold nights the intakes are partly closed; otherwise there is no adjusting. The lowest temperatures recorded in the pens was 20 F when the outside temperature dropped to –30 F. The pens are insulated. During 1940-41 before the fans were installed, Mr. LaValle purchased seven tons of litter compared with three tons in 1941-42 after the fans were installed.

Stewart L. Purdie of the Mapleton Egg Farm, near Auburn, N. Y., who has an installation similar to Mr. LaValle's, said he had tried all sorts of methods of ventilation in his 35 years in the poultry business with little success. He never had a dry house during the winter until the fans were installed. "We were cleaning our pens on the average of every ten days. From February, when the fans were installed, until May the litter was not changed and was still in good condition. In a full season we would save about 140 hr of labor in caring for our 1400 layers."

The Henry Knoble, Jr., poultry house near Syracuse, N. Y., is a 125-hen house, 19x25 ft. It is equipped with a 10-inch, 1/30-hp fan having a capacity of 250 cfm (cubic feet per minute). The outtake flue is a 12-in furnace pipe running to within 16 in of the floor in the center of the pen. A throttling damper which can partly shut off the outtake is used for regulating the air flow. Windows are used for intakes. After some adjusting, performance has been satisfactory with air flows ranging from 90 cfm to full capacity.

TABLE 1. FLOCKS OF CHICKENS OVER 4 MONTHS OLD (April 1940)

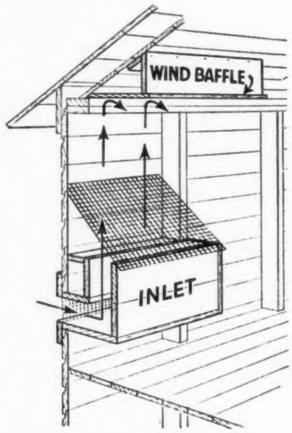
		Flock Size			
Geographic Division	No. of farms	100-199 Per cent	200-399 Per cent	Over 400 Per cent	0-100 Per cent
New England	135,190	4	4	4	88
Middle Atlantic	348,100	12	7	4	77
East North Central	1,006,095	20	5	1	74
West North Central	1,090,574	28	10	1	61
South Atlantic	1,019,451	4	1	*	94
East South Central	1,023,349	3	*	*	97
West South Central	964,370	9	1	*	90
Mountain	233,497	8	3	1	88
Pacific	276,173	5	3	5	87

*Less than 1 per cent

This paper was presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at New York City, November, 1945.

GEORGE W. KABLE is editor, Electricity on the Farm Magazine.

Starting with these installations of some four years standing, the New York Farm Electrification Council is conducting investigations of ventilation and has made an experimental installation in cooperation with the poultry department of Cornell University. On a recent farm tour with the New York Council I asked several Cornell agricultural engineers if the gravity systems recommended in Cornell bulletins worked satisfactorily, and if so, why the electric study was being undertaken. My own conclusion from the replies was that some gravity installations do work well where conditions are right and the installation is properly made; some others have not been too satisfactory.



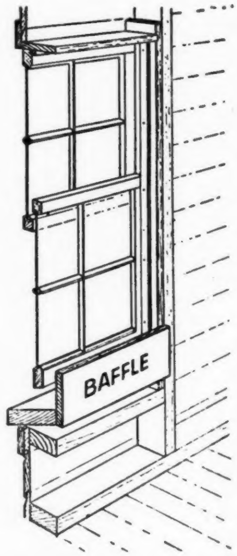


Fig. 2 *(Left)* Air inlet according to Cornell recommendations
Fig. 3 *(Right)* Regulation double-sash windows used as air intakes

Present Design Recommendations. In the electric ventilation systems that have been installed in New York state, the design has been essentially the Fairbanks-Goodman system of intakes with a fan outtake in place of a gravity flue. The intakes have been placed by trial to get dryness throughout the house. Cornell Extension Bulletin 315 recommends the following: One inlet for every 120 sq ft of floor area. No inlet should be within 8 ft of the outtake flue. It has been found by trial that the best size of inlets is about 60 sq in. The inlets from the outside should be near the floor level and the air carried up in a flue inside the house and discharged upward against a baffle at the ceiling (Fig. 2). This helps to avoid drafts and mixes the incoming cold air with the warm air at the ceiling.

Tip-in windows are not recommended as intakes because the sweep of air into the house tends to channel and create drafts. Tip-in windows can be used as intakes when sawed off and baffled as done on the LaValle farm. They may be used as tip-in windows in the summer but are not tipped-in for winter ventilation.

Regulation double-sash windows that can be raised two inches from the bottom and the incoming air baffled and directed upward (Fig. 3), have been used as intakes and have an advantage in keeping the frost off the glass.

One outtake flue is provided per pen. In long houses separated into pens, the solid partitions may be replaced by wire screen and one outtake used for several pens. Flues should be round or square and with a cross-section area at least twice that of the fan opening. The flue extends down to within 16 in of the floor in order to remove the colder air from the house. The fan is placed in the wall near the ceiling on the leeward side of the house (Fig. 4). A sliding or hinged door is usually placed near the top of the outtake flue opposite the fan for summer ventilation.

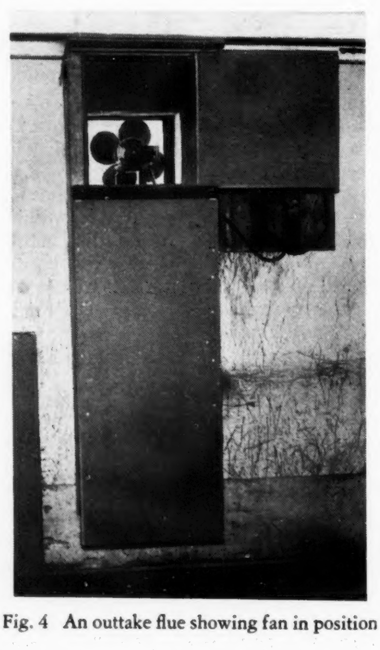


Fig. 4 An outtake flue showing fan in position

In the installations described, the fan size has been based on removing 1 cfm of air for each hen. So far as I know, this is an empirical figure. For summer ventilation, the windows would usually be thrown open and the fan not used, except on still, hot days.

Fan Requirements. There are several important requirements for poultry-house ventilation fans. The blades should be of such design that the motor cannot be overloaded and excessively heated by changes in operating pressures. They should also be shaped so as to accummulate a minimum of dirt and should be non-corrosive.

Motors should be enclosed and protected for operation in a moist, dirty atmosphere and have bearings and a lubrication system which will permit continuous day and night operation for five-month periods with little attention. The motor type should be such as to insure immediate starting whenever the current is turned on even after long periods of disuse under poultry-house conditions. Thermal protection should be provided to preclude any possibility of overheating and fire in case of stalling. Explicit instructions for care and lubrication should be securely attached to the motor. Either ball or sleeve-bearing motors will perform satisfactorily providing the lubrication system is as near foolproof as possible.

Many Ventilation Systems Devised. That there is need for and interest in good poultry-house ventilation is evidenced by the number of different systems which have been devised. They include the open-front, curtained-front, homemade and commercial gravity outtake flue systems, several types of rafter ventilators, various window ventilators, the slot system and a number of different positive systems using electric fans.

Basic Approach to Engineering Design. Certain basic information must be known or assumed by the engineer before he can intelligently apply engineering principles to the design of a ventilation system. He must know, or assume to know, what the hen or the owner of the hen wishes to accomplish by ventilation.

Based on observation and experience we have assumed that ventilation must remove the excess moisture produced by the hens in order to keep the litter dry and prevent condensation on walls and floor. In removing this moisture we assume that we will also remove objectionable odors and bring in an adequate supply of fresh air. This must be done without lowering

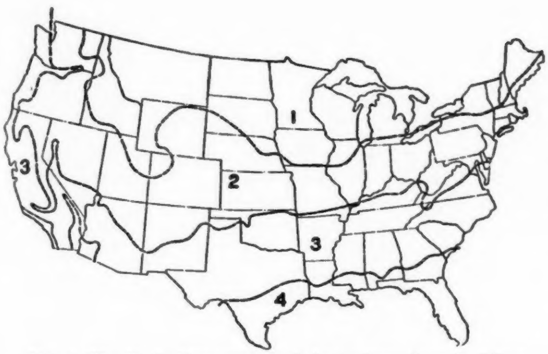


Fig. 5 The U. S. Department of Agriculture farm building zone map

the temperature sufficiently to interfere with egg production or the health of the birds, without unduly increasing feed consumption for maintaining body heat, and without making the house uncomfortable or cold enough to freeze water pipes.

Since this paper was originally prepared, certain functional requirements for laying house design have been presented in USDA Circular 738[1]*. These estimates based on the best available information, are as follows:

"In houses for commercial egg production with ordinary feeding, winter temperatures above the following minimums are desirable:

	Ordinary F	Extreme F
Farm building zone 1 (Fig. 5)	32	15
Farm building zone 2	40	20
Farm building zone 3	45	25
Farm building zone 4	50	32

"Keep the relative humidity below 80 per cent in ordinary winter weather.

"The moisture content of the litter should not exceed 40 per cent."

An Analysis by Mitchell and Kelley. As a guide in the design of poultry house ventilation, Mitchell and Kelley[2] compiled fundamental data on the production of heat, carbon dioxide and water by different varieties and classes of poultry. The following analysis is in part summarized from their report:

The total heat produced by a hen is the sum of the basal heat (measured in a calorimeter after a period of 48 hr of fasting) plus the heat liberated by muscular activity (assumed at one-half the basal heat) plus the heat increment due to feed. Part of the heat produced by the birds is in the form of sensible heat and part as heat of vaporization of water in the exhaled breath. This heat of vaporization is not released from its latent form unless the vapor is condensed into water. Since one purpose of ventilation is to remove this excess moisture from the air before it condenses on walls and floor, its latent heat does not become available for warming the building.

Experimental data indicate that the percentage of total heat lost as vaporized water — and therefore the amount of water exhaled — is small at low temperatures but increases rapidly as the environmental temperature increases. This relation seems to be a logarithmic one which may be represented by the equation $W = 7.14e^{0.06438t}$, in which W is the percentage of heat produced in the form of vaporized water, and t is the environmental temperature in degrees Centigrade. Solving this equation and changing t to degrees Fahrenheit, the percentage of total heat produced in the form of water vapor at 32 F is 7.1 per cent, at 50 F it is 13.6 per cent, and at 106F (the body temperature of the hen) all the heat produced is in the form of vaporized water. These relationships of sensible heat and water vapor production for a typical 4-lb bird are shown in the curves in Fig. 6. Superimposed on the curve giving the percentage of latent heat (or moisture) produced is a curve showing the relative moisture-holding capacity of the atmosphere at different temperatures. Note that as the moisture-holding capacity of the air drops with falling temperature, the amount of moisture exhaled by the birds drops in almost the same ratio. This is an important consideration in ventilation design as it means that a fan designed to remove exhaled moisture at any house temperature will remove it with almost equal effectiveness at any other house temperature, assuming of course that the incoming air would always have the same relative humidity. The moisture and sensible heat curves show that at low temperatures when the exhaled moisture is low, the major portion of the heat produced by the bird is sensible heat available for warming the surrounding air and walls.

If the environmental temperature drops to a low point, the heat produced by the bird will also increase due to increased muscular activity or to increased food consumption. For a bird weighing 4 lb, consuming food and moving about normally, the critical temperature at which an increase in heat production from activity, feed or external sources must occur is estimated at about 20 to 22 F. The critical temperature would be higher than 22 F for a sleeping or inactive hen.

Mitchell and Kelley give the following example of the use of their estimated data in the design of a ventilation system for a shed roof house 20x30 ft, housing 200 4-lb Plymouth Rock hens.

At a house temperature of 82 F (for which quantities were estimated—Table 2) these hens would produce hourly 7866 Btu, and vaporize 3 lb of water per hour which must be removed by ventilation. At 82 F, however, the house would be wide open and the moisture would be dissipated. At 50 F only 1.045 lb of water vapor would be produced hourly. (And at 32 F, 0.503 lb.) With a house temperature of 50 F and relative humidity of 75 per cent, and incoming air at 15 F and 80 per cent, 4.2 cu ft of air per hour per bird (0.07 cfm) would be required to maintain a desirable limit of carbon dioxide (11 parts in 10,000), and 16 cu ft per hour per bird (0.267 cfm) would remove the 1.045 lb of moisture per hour.

The heat removed from the house by the 3200 cu ft per hr (16 cu ft per hr × 200 hens) of ventilating air

Fig. 6 Curves showing relationships of sensible heat and water vapor production for a typical 4-lb hen

*Superscript numbers refer to appended references.

amounts to 2128 Btu per hr. The 200 birds produce 6765 Btu of sensible heat (plus 1100 Btu of latent heat of vaporization). The difference $6765 - 2128 = 4637$ Btu per hr is available to care for heat losses from the house. Actual heat losses from the house, both with and without insulation, were estimated and the conclusion reached that the birds could not supply enough heat to maintain a 50 F house temperature with a 15 F outside temperature.

This example is cited for two reasons: first as a basic approach to poultry house ventilation design, and, second, to point out that the assumptions we must make are as important as the method of approach. In this case the assumption of a 50 F house temperature with a 15 F outside temperature is an impossible one even with the removal of so small a quantity of air as 0.267 cfm per bird. Present practice is to remove 1 cfm. It would also be impossible in most houses if no air was removed.

Moisture in Droppings. In the example cited no account has been taken of water voided in the droppings. Yushok and Bear[3] give the amount of liquid voided by a 4-lb hen as about 1/4 lb per day. Obviously this water must be disposed of or the litter would soon contain more than the 40 per cent moisture recommended by some investigators[4] as the maximum consistent with cleanliness and good sanitation. The two ways to dispose of it is to remove the droppings themselves, or to evaporate the moisture from the droppings and exhaust it through the ventilation system. We can also add to this the water spilled around water fountains and water shaken off the beaks and wattles of the birds.

With our present information a calculation of fan capacity to remove this water would necessarily be an approximation. In the example cited above, a 4-lb hen exhaled 1/8 lb of water vapor per day at a house temperature of 50 F, and the air movement to remove that moisture was 0.267 cfm. Add the 1/4 lb of water excreted, and the air movement called for, if the water were vaporized, would be $3 \times 0.267 = 0.801$ cfm which is still under the 1 cfm now recommended. The exact solution is not that simple. Part of the droppings are from the roost area and are not mixed with the litter. Some of the excreted water is removed in periodic cleaning of the dropping boards. The excreted water is not in the form of vapor. The evaporation of water from droppings mixed with litter is dependent on the difference in vapor pressure of the moisture in the litter and that of the moisture in the overlying air. The vapor pressure varies with both temperature and relative humidity. As the temperature and relative humidity in the house change from day to night the amount of moisture taken from the litter or condensed in it will also change. The litter will give up moisture when the house air temperature is high providing the relative humidity is low enough so the dew point is not reached in the litter; it will also give up moisture at night when the litter temperature may be higher than that of the air, if the air humidity is low enough to keep the vapor pressure of the moisture in the air lower than that of the moisture in the litter.

Recent reports from Massachusetts State College tell of litter being used in the laying house for two years and remaining drier the second year than freshly built-up litter. The report hints that some chemical or bacterial action might be responsible. My own opinion is that the old litter consisting of a finely broken combination of litter and droppings may have so much better insulating properties that the floor and litter remains warmer and above the condensation point for the overlying air and vapor mixture.

Heat and Ventilation Formulas. J. L. Strahan in "A Rational Approach to Poultry House Design"[5] presents this basic heat equation

$$H = \frac{VD}{50} + ACD$$

in which H is the Btu produced per bird per hour; V is the cubic feet of air discharged from the house per bird per hour; D is the difference in air temperature inside and outside the house; A is the square feet of wall and roof area per bird housed; C is the average heat loss through the walls, windows and roof per square foot per hour per degree difference in temperature, and 50 is the cubic feet of air raised 1 F by 1 Btu at 32 F. Transposing terms, the formula for computing insulation and wall construction becomes

$$AC = \frac{H}{D} - \frac{V}{50}$$

in which the wall type represented by AC is dependent upon the amount of ventilation and the assumed difference in inside and outside temperatures. Or, if it is desired to compute the ventilation permissible for an existing structure based on maintaining an assumed temperature difference inside and outside,

$$V = \left(\frac{H}{D} - AC\right) 50 \qquad \text{or } D = \frac{50\,H}{V + 50\,AC}$$

Here the variables are the number of hens housed, the assumed difference in temperatures to be maintained, and the possibility of adding insulation.

The value of H for light and heavy breeds is given in Table 2 condensed from the paper by Mitchell and Kelley[2] and changed to English units. The formulas may be used to determine the required fan capacity for an assumed temperature differential or to determine what differential can be maintained with a given air movement.

TABLE 2. ESTIMATED DAILY HEAT, CO_2 AND WATER PRODUCTION OF CHICKENS[2]

Body weight	Males	Females	Total heat produced	CO_2 produced	Water vaporized at 82 F	Total water excreted at 82 F
lb	weeks	weeks	Btu	cu ft	lb	lb
WHITE LEGHORNS						
0.077	0	0	40	0.07	0.016	0.024
1.0	6.9	8.2	438	0.78	0.168	0.228
2.0	12.5	14.8	616	1.10	0.236	0.318
3.0	18.2	22.4	771	1.34	0.296	0.395
4.0	25.4	28.3	935	1.66	0.358	0.476
WHITE PLYMOUTH ROCKS						
0.077	0	0	40	0.07	0.016	0.024
1.0	6.6	6.7	438	0.78	0.168	0.230
2.0	9.7	10.7	632	1.13	0.242	0.335
4.0	15.7	19.4	946	1.66	0.362	0.494
5.0	19.3	25.4	1125	1.95	0.432	0.575

Past Research Bearing on Basic Design. Table 2 was computed from estimates based on studies of growth, metabolism and nutritive requirements of chickens, ducks, geese and turkeys. They are estimates and not actual measurements under the environmental conditions where winter ventilation becomes desirable.

Giese[6], in experiments at Iowa State College, found that single hens with a measured air supply, so restricted that the air became practically saturated and the hen's feathers wet, continued to live in apparent comfort and health and to produce as many eggs as hens in well-ventilated pens.

Huttar, Fairbanks and Botsford[7] in studies at Cornell University reported "Birds seem to slow down in their

activity, and production lags when the temperature drops below 10 F in the pens and remains below for more than three or four hours;" and, "Practically no frosting of combs and wattles of birds occurs above 10 F."

Tests in Wyoming[8] showed that in moist air the combs froze at 6 F; at 8 to 10 F, egg production was reduced 25 per cent; and at 0 F the hens stopped laying.

At the Nebraska Agricultural Experiment Station it was found[9] that maximum egg production was obtained when the temperatures were not permitted to fluctuate widely. Their results indicated that maintaining fairly uniform temperatures might be of greater importance than providing higher but rapidly changing temperatures.

Richardson and Huber[10] reporting for Maine conditions say the greatest difficulty is in avoiding moisture and frost on floors, walls and ceilings; also, that the trouble with natural flue ventilation is that "when the weather is extremely cold and the wind blows hard, they 'pull' the hardest — just when they shouldn't."

In a research thesis on dairy barn ventilation by A. W. Clyde[11] he points out that the condensation of exhaled vapor on walls to recover the latent heat of vaporization is futile, as the cold walls conduct more heat out of the barn than is released within it. He also found that when the stable air is in motion the condensation point on the walls is from 1 to 4 F below the dew point in still air. This may be important if the prevention of condensation is a controlling design factor in ventilation. One other observation was of interest. Automatically controlled, movable louvers in the outtake tended to restrict the air flow and also to freeze either in an open or closed position in very cold weather.

Since 1942, C. I. Gunness of Massachusetts State College has been experimenting (results not yet published) with a radically different electric fan ventilation system in an 18x24-ft uninsulated house containing 100 birds. The fan is located in one end of a horizontal duct 12 in above the floor and 10 ft long at the front of the house and discharging air horizontally across the floor toward the rear of the house. The fan has a capacity of 300 cfm. The fan draws 60 cfm through an inlet from the outside and 240 cfm is recirculated within the house, the fan intake being 4 ft above the floor. Gunness reports that the air circulation across the floor and under the rafters seems to help dry the litter and prevent excessive frost on the ceiling without producing harmful drafts on the hens. With the windows closed the house has a rather high humidity, but the temperature has been kept higher than if slot or window ventilation had been used.

The USDA Bureau of Plant Industry, Soils and Agricultural Engineering, has a single-bird calorimeter with which they have been making some studies of hens. They also have under construction a flock calorimeter in which actual measurements can be made of the production of heat, CO_2 and moisture under actual laying house conditions.

Other Considerations in Design. In an article by R. E. Ogle[12] telling how champion layers are managed in the 13 bird pens of the New York State Egg Laying Contest, the statement is made "the modified Cornell rafter ventilation system works just about 100 per cent." This is a gravity system in a house with 96 sq ft of floor space and the outdoor temperatures were from −30 to 98 F. I have calculated that, even if only a front and rear wall and roof were exposed, the building surface radiation area per bird was 21 sq ft—almost twice that of a conventional 20x20-ft, 100-hen house. From theoretical design considerations it would seem utterly impossible for those 13 hens to produce enough heat to make any gravity ventilation system function. Either our theory is wrong or there are other factors which make that ventilation system work. Possibly more floor area per bird was responsible in this case.

In designing ventilation and housing we must remember that the hen is a relatively small heat-producing unit. Heat tends to bank at the ceiling so the hen must heat a column of air 8 to 10 times her height before she benefits down on the floor from a rise in temperature. Not only is she a small heating unit, but the volume of air in the house to be heated and the square feet of radiation surface in walls and roof are greater per animal unit than for any other type of livestock shelter. The square feet of wall and roof surface per hen also increases as the size of house diminishes, so small houses are harder to heat and to ventilate without lowering the temperature excessively. Simply put, the hen house is built for the men as well as the hen.

It has already been stated that the critical temperature for an active hen was estimated at 22 F, and for an inactive hen somewhat higher, say, 32 to 40 F. Hens are active during the daylight hours. This is also the time when house temperatures usually warm up due to sunshine or a daytime rise in outside temperature. The critical period when house temperatures may be lowered hurtfully by ventilation is at night. Without offering any specific designs, I would like to suggest that laying houses might be susceptible to new and radical designing which would provide for this critical period. I have in mind getting the birds higher up in the house, or possibly lower down, if the residual heat in the floor makes floor temperatures higher than ceiling temperatures. Also that the birds be surrounded by nearby heat-reflecting surfaces, bearing in mind that warm walls make rooms comfortable even when the air temperature is low.

The saturated atmospheric condition under which the single hen performed well in Iowa, and the temperatures down to 10 F which did not seriously affect the New York and Wyoming hens are not accepted by poultrymen as being desirable conditions or conducive to high egg production. There are several reasons. First, high humidity tends to produce wet litter, wet walls and a damp frosty atmosphere in which *men* do not like to work, and *we assume* hens do not like to. Wet litter makes labor, and costs money for replacing. With a *flock* of hens in distinction to one hen in a pen, wet litter becomes unsanitary. More eggs need to be cleaned. The one factor of litter cost and labor may be the chief incentive for good ventilation. Preventing building deterioration from wet walls and floors, removing obnoxious fumes, saving feed by saving heat, and preventing drafts through control of the air supply are probably all of greater importance than supplying "fresh" air.

It is still a moot question whether ventilating fans should be operated continuously during the winter or under thermostatic control to cut off at a predetermined low temperature. Automatic control aids uniformity of temperature. Solenoid control of adjustable louvers or a damper in the outtake flue would be theoretically desirable. Practically the additional cost and the added mechanism to get out of order might offset the advantage. Simplicity and ruggedness in farm equipment usually gives better results than complicated equipment designed for nicety of control.

Suggestions for Further Investigations. Following are some points on which further investigation might be warranted:

At just what threshold temperature or difference in inside and outside temperatures is the health and production of a hen hazarded?

What is the *actual* heat and moisture production of hens

of different breeds, ages and weights under different environmental conditions?

What is the critical relative humidity to preserve health and production under flock conditions?

How much water must be evaporated from droppings and removed by ventilation to keep litter in usable condition?

Why does litter keep drier the second year than the first year of use?

Can a figure be determined for the cubic feet per minute per bird which must be removed by ventilation in the different housing zones and for different size hens?

We need more data on the heat retained in buildings and in the ground that is available as a supplement to the heat produced by the hens.

Additional studies are needed on number, types and spacing of intakes, bearing in mind that the cost should be kept low and windows used, if possible.

The effect of recirculation in providing higher temperatures at floor or roost level and other desirable conditions merits further study.

Studies should be made of actual suction pressures developed within typical insulated and uninsulated houses when exhausting 1 to 4 cfm of air per hen to learn the actual pressures against which fans must operate.

Special poultry house ventilation fans need to be made available. They should have these characteristics: Non-overloading and non-corroding blades that are easy to keep clean. Cost should be reasonably low. Motors must be capable of operating continuously for five-month periods with little attention and in a dirty, humid atmosphere. They must be fire safe and easy to care for by untrained users. There is a question whether fans should be two-speed, or constant single speed with different size fan blades or different pitched blades, or with dampers in outtakes to govern air flow. Manufacturers and ventilation designers need to get together on fans.

Should air volumes be controlled at low temperature peaks by manual control of intakes or outtake dampers, or by automatic thermostats or solenoids?

CONCLUSIONS

Sufficient information is available to warrant the installation of electric ventilation systems in poultry houses. They should be watched, however, and studied for possible improvements in design and operation.

We need suitable fans at prices which will permit rugged construction and carefree operation without making the ventilation cost prohibitive.

We must decide whether the most important consideration in ventilation is dry litter, dry walls, unfrozen water, the poultryman's comfort, etc., and design for that purpose.

Research work on the effect of ventilation on hens should be extended.

It should be borne in mind that electric ventilation is justified only if it does a better job or does it cheaper or more reliably than other systems of ventilation.

Ventilation is only one factor in poultry management. It must be considered in connection with building insulation, feeding, labor requirements and other management problems, and not as an end in itself.

REFERENCES

1 Wallace Ashby, T. A. H. Miller, Geo. L. Edick and R. A. Lee. Functional Requirements in Designing Laying Houses for Poultry. USDA Circular 738, Oct. 1945.

2 H. H. Mitchell, Ill. Ag. Exp. Sta., and M. A. R. Kelley, USDA. Estimated Data on the Energy, Gaseous and Water Metabolism of Poultry for Use in Planning the Ventilation of Poultry Houses. Journal of Agricultural Research, vol. 47, no. 10, Nov. 15, 1933.

3 W. Yushok, F. E. Bear. Poultry Manure — Its Preservation, Deodorization and Disinfection. N.J. Agr. Exp. Sta. Bul. 707, 1943

4 F. B. Charles, A. E. Tepper, W. T. Ackerman. The Problem of Moisture in Poultry House Litter. N.H. Ag. Exp. Sta. Bul. 332, 1942.

5 J. L. Strahan. A Rational Approach to Poultry House Design. AGRICULTURAL ENGINEERING, vol. 21, no. 9, Sept. 1940.

6 Henry Giese. Dept. of Ag. Eng., Iowa State College. Tests in 1930 (Uupublished).

7 John C. Huttar, F. L. Fairbanks, and H. E. Botsford. Ventilation of Poultry Houses for Laying and Breeding Hens. Bul. 558 Cornell Univ., Agr. Exp. Sta., 1933.

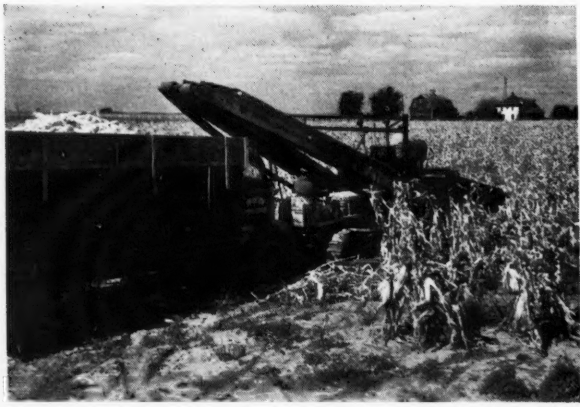
8 J. A. Hill. Wyo. Agr. Exp. Sta. Rept. 1929-30, pp. 13-20.

9 C. W. Smith. The Relation of Environmental Conditions in Poultry Houses to Winter Egg Production. Nebr. Agr. Exp. Sta. Bul. 247, 1930.

10 Richardson and Huber, Univ. of Maine. Ag. Exten. Serv. Bul. 216, 1937.

11 A. W. Clyde. Thesis: Control of Temperature and Humidity in Dairy Barns Using an Automatic Fan Ventilation System, 1929-30. Iowa State College (Unpublished).

12 R. C. Ogle. How Champion Layers Are Managed. Poultry Tribune, July-Aug., 1945.



Two views of an innovation in corn picking developed by the Pfister Hybrid Corn Co., El Paso, Ill. Lester J. Pfister, owner and manager of the company, and an A.S.A.E. member, designed and constructed this 4-row corn picker by modifying and combining two 2-row pickers, and adding an auxiliary engine for driving the picker mechanism. A Caterpillar Diesel tractor furnishes the tractive power for the equipment

Saving the Good Earth

By M. L. Nichols
MEMBER A.S.A.E.

IN a period of national and world-wide reconstruction, reconversion and reorganization, it is extremely important that we consider the essentials upon which stable social orders and developments are based. Today a large proportion of the people of the world are suffering from lack of food, clothing, and shelter. These basic and biological necessities of life are absolutely essential to future peace and human welfare. The agricultural engineering profession must assume its responsibility in preserving that peace and assuring that welfare. It has an unequalled opportunity for service in the conservation, management and productive use of soil and water assets necessary to supply the world's food, clothing and shelter. Little glory in the war and in the victory has gone to the agricultural engineer. Without his work, however, the tremendous war production and the simultaneous organization of millions in the armed forces would have been impossible. For it is only by the mechanization of food and fiber production that one man has been enabled to feed and clothe dozens of others fighting or producing the munitions of war. The farm tractor and other machines contributed more to winning the war than did the atomic bomb, and they will contribute much more to winning and maintaining the peace.

There can be no contentment or satisfactory living without adequate clothing and nutrition, and both food and clothing come from the soil. All progress depends upon the production of these biologic necessities in such an abundance and by such a limited number of the population that there shall be time available for scientific advancement and educational activities. I am sure that the present enviable position of the American citizen is owing as much to the personal efficiency in production of the American farmer as to any other one factor. This efficiency in production is due, in turn, to the work of the agricultural engineer. But even with our much-vaunted efficiency there is a wide gap between what we know and what we are putting into practice on farms. It is the responsibility of the agricultural engineer to put into practice what we know. The pay-off of science depends upon the engineer.

Unfortunately in many cases our abundance of the essentials of good living has been obtained by exploitation and waste of the soil and water resources. In some instances the misinformed intimate that bad land management and disastrous economic conditions are inherent in the use of power machinery on a large scale. This shows an absurd failure to comprehend the whole trend of modern scientific development. Beneficial use of any kind of power requires intelligent understanding. Fortunately the very power equipment which enables the farmer to produce efficiently provides him with the means to do the things necessary for conservation of soil and water. What is required is a better understanding of the correct use of our soil and water resources than has been general in the past and a change in our concept of land use.

We have those who object to further mechanization of agriculture because of already existing surpluses. Conservation also contributes to production in abundance. During the relatively short existence of the Agricultural Adjustment Agency, it has been amply demonstrated that in many places reduction of acreage for the purpose of conservation has resulted in no material decrease in total production. In many cases there has been an actual increase, due largely to better land use. Couple this better land use with shortening of hours by mechanization and we commence to visualize possibilities of an economic future for the farmer comparable to that of the better-paid industrialists. To object to personal efficiency and to the ability to produce in abundance because of surpluses is an absurdity. We must, however, recognize that surpluses present very real and perplexing problems under a free economy where the law of supply and demand governs prices; also that there is great need of intelligent adjustments in the use of the national soil and water resources. The solution of these problems must permit the highest individual efficiency in production and the conservation of our soil and water.

When we leave the broad over-all field of national economic policies of land use, which is in the realm of social science, and come into the field of physical science in land use we can feel much more sure of ourselves. The system of land capability classes being developed by the Soil Conservation Service and the cooperating state agricultural experiment stations, while not perfect in its present state, is developing into a logical and sound basis for farm and ranch planning. It merely classifies land on the basis of conservation practices necessary for sustained productive use.

In reality the classification of land must be based upon our knowledge of how to utilize the natural forces that affect it under various climatic conditions. Management of any land class must have as its objective the development and maintenance of desirable soil condition for plant growth. To explain our meaning of soil condition let us take two fields of similar soil. One has been row-cropped up and down the slope continuously, with little organic matter or fertilizer added. The other has been properly fertilized and protected by terraces; it is contour-tilled and protected by soil-building and soil-conserving crops and the use of their residues; rainfall is conserved and stored in the soil. The first returns a fifth of a bale of cotton per acre, the other a bale. The soils have the same classification and the climatic conditions are practically identical. The difference in yield is due to the soil condition produced by management.

As we use the term "condition" it embraces both tilth and level of productivity. We recognize soil condition is constantly changing and dynamic in its nature. There is nothing new in this concept. I am using it merely to emphasize its importance as an objective. Call it what you will, this concept is necessary for sound planning of farms for production and conservation. To attain optimum soil condition, we need not only the art and science of agronomy but also the skill and science of engineering.

There is a general parallelism between processes of animal nutrition and soil processes affecting plant nutrition. I would like to use it to explain this concept. We all know that in the stomachs of a cow grain and roughage are broken down and in part at least digested by bacterial action. In this process vitamins and other materials are produced and made available. The cow carries this manufacturing plant around with her and maintains a desirable environment for such action. The plant, on the other hand,

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Illinois, December, 1945.

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has no machinery for performing such action and it must take place externally in the soil. Soil bacteria and other microorganisms break down the organic material and make it available to the plant. While mineral fertilizers are very important and must be supplied in most cases, they do not take the place of the natural soil processes in rendering organic materials available for plant growth.

The problem of soil management is essentially one of keeping the soil in condition for production by mechanical manipulation so as to produce proper aeration and the addition of mineral and vegetable materials. A portion of the production is harvested as crops, directly or by animals, and a portion must be returned to nourish the life within the soil itself. This process of production can be speeded up by increased use of soil-building crops and their application to the land and by reducing losses through conservation practices. Soil building mathematically follows the growth curve law. Productivity may go up or down—it is never static.

There is a lot yet which we must learn to do in carrying forward our program of conservation, management and proper use of our land resources. This involves not only the development and application of conservation practices by agricultural engineers but the simultaneous development and application of power equipment in farm production.

Under any system it requires timely and intelligent use of mechanical power to translate such an understanding into higher levels of productivity. In the maintenance of the soil as a manufacturing plant it is necessary that we as engineers recognize the dynamic concept of the soil and strive to understand and treat it as a live and vital element of our whole civilization. This is particularly important at the present time, when we are changing from animal to mechanical power. Under the old animal-power situation, one-fourth to one-half of our land was used to feed the animals which provided us the power. Now nearly all of the land is available for producing human food. This means a possible increase in population. It is equivalent to acquiring a tremendous new land mass for the nation. It brings with it, however, some entirely new problems. For example, the farmers in New Jersey formerly depended in large part upon manure from the horses used for transportation in New York City. The truck and automobile have completely eliminated this source of supply, and substitutes must be grown or otherwise obtained by New Jersey farmers.

Fortunately the plant materials necessary for the soil-building processes can be utilized in production of meat and milk and of animal fibers with very little loss to the soil-building process, except in the case of mineral elements which must be supplied. Soil-building crops and their use bring new engineering problems, not only in the development of special mechanization and methods for using such plant materials as green manures and crop residues, but also in the housing and sheltering of more animals and the construction for industrial utilization of animal products.

As understanding of this field of production gradually unfolds with the intelligent and conserving use of power and the development of know-how, we shall approach the limits of the capacity of our good earth to maintain increasing population. The limitations, according to our present knowledge, appear to be chiefly those of plant growth. The requirements for plant growth essentially are (1) physical support of the plant, (2) supply of nutrients which we have touched upon briefly, (3) solar energy which is needed for the synthesis of new plant materials, and (4) air and water.

We have already given considerable attention to these requirements. Physical support rarely limits production. We have touched on the nutrient problem, which is being given a great deal of study. So long as solar radiation is the source of energy for photosynthesis there is little we can do on a field scale to improve this factor of plant growth, but there are opportunities for better utilization. We should not overlook, however, the vast potentialities of the southern regions of this country and of the tropics in future world development, with their long periods of hot sunlight and their adequate water supplies. The agricultural potentialities of the South will become a greater and greater asset to the nation as we learn more about controlling environmental factors. The agricultural possibilities of the tropics, with present control of tropical diseases, appear to be practically unlimited. The energy potential is there.

Despite the tremendous significance of water in agriculture, we are just commencing to realize that we can do something about its regulation and control in the East in the interest of agricultural production. We have accepted climate as an act of God and have given little thought to overcoming droughts or floods. Recently there has been a great demand all through the eastern part of the country for irrigation during seasons of drought. Many people are beginning to realize that water is the limiting factor in the production of many of our crops in the East. We are now under pressure to establish projects dealing with impounding water, renewing ground water supplies, and use of this water for tiding crops over drought periods. The utilization and storage of water and its protection against wasteful evaporation are now being recognized as one of the greatest challenges to the agricultural engineer in the East.

The West, of course, has long recognized water as the limiting factor of life in its semiarid areas. It is looking forward to tremendous developments in the immediate future, not only in the great expansion of work by the Bureau of Reclamation and the Army Engineers but in the systematic development of whole river systems. Whatever the national policy in these undertakings turns out to be, the agricultural engineer has a very definite professional responsibility in their development, which will largely determine what the United States will be in the future.

Research in Agricultural Hydrology

ALL ENGINEERS occasionally have unique concern with phases of basic sciences or related applied sciences and must resort to their own resources for fundamental research for solution of their own important problems. Such is the case with several phases of hydrology, which have been of minor or incidental interest to others but which are of primary concern to agricultural engineers.

Two examples are the development of basic physical concepts and laws governing the entrance of liquid water into the soil and its movements through the soil and substrata; and the physical and biological influences on water vapor exchanges between the soil and atmosphere, and *vice versa*. Other less basic problems of particular importance to agricultural engineers are establishment of the correlations between the characteristics and conditions of relatively small agricultural watersheds and their runoff behavior, and the probable influences of rainfall character on runoff.

These problems involve soil physics, fluid mechanics, thermodynamics, meteorology and the natures of plants and soil organisms. Probably no technicians are better qualified than agricultural engineers to organize and supervise research on problems involving such combinations of physical and biological considerations. — *R. B. Hickok* at 1945 A.S.A.E. fall meeting.

The Application of Mechanical Refrigeration to Ranch Egg Cooling

By F. W. Lorenz

THAT market eggs should be cooled soon after they are laid is well known; warmth, even for a short time, hastens egg deterioration and may cause a considerable financial loss to the producer. Evaporation of moisture is hastened by elevated temperature and the firm albumen structure is weakened. These effects reduce the egg's market value and also its culinary value so that proper handling of eggs on the ranch becomes a matter of importance both to the poultryman and to the consuming public.

The most desirable temperature for egg-quality maintenance has been determined, but the most practical temperature remains to be worked out. The optimum temperature is generally agreed to be just above the freezing point of egg albumen, which is 28 F (degrees Fahrenheit). For example, Van Wagenen, Hall and Altmann[1]* reported that eggs may be held 10 days at 35 F with less quality loss (as measured by albumen score—see Fig. 1) than occurs in four days at 55 F; likewise, 10 days at 55 F results in less loss than four days at 80 F (Table 1).

TABLE 1. INCREASE IN AVERAGE ALBUMEN SCORE DURING SHORT HOLDING PERIODS AT VARIOUS TEMPERATURES
(Summarized from Van Wagenen, Hall and Altmann, 1939[1])

Time eggs held (days)	Increase in albumen score* at different holding temperatures				
	35 F	45 F	55 F	65 F	80 F
4			0.30		1.05
8			0.63		1.60
10	0.22	0.52	0.86	0.94	

* See Fig. 1.

For hatching eggs the requirements are different, and considerably more critical. Market-egg-quality characteristics are of minor importance; the criterion is the survival of the embryo. The temperature at which the embryo starts to develop is commonly accepted to be 68 F (though a recent paper by Funk[2] suggests that 80 F is the minimum temperature for observable development). When development starts at temperatures appreciably below incubation temperature (around 99.5 F), the embryo dies or develops abnormally, so that embryo development should be prevented during the holding period prior to incubation. The maximum safe holding temperature for hatching eggs is thus probably about 65 F.

Cold also damages the germ[3,4]; Scott[3] found 55 F to be the optimum holding temperature (Table 2). The accepted "safe" range is 40-65 F, although eggs can be held below that temperature without much damage for five or six days.

TABLE 2. HATCHABILITY OF EGGS STORED AT VARIOUS TEMPERATURES BEFORE INCUBATION
(Summarized from Scott, 1933[3])

Days held	Hatchability of fertile eggs held at 36.3 F per cent	54.2 F per cent
0- 6	63.3	69.4
7-13	5.3	66.7
14-20	0	68.0
21-27	0	44.3

The treatment accorded eggs awaiting delivery to the receiving station varies considerably on different ranches[5]. Many poultrymen hold their eggs in such places as the feed house, the garage, or the back porch. Where attempts are made to cool eggs, rooms equipped with evaporative coolers or basements with or without humidifiers or fans to utilize the night air are used. The temperature obtained in all of these is highly dependent on the outside temperature and subject to diurnal and seasonal variation. The outside diurnal minimum usually sets the minimum cooler temperature, and the average cooler temperature is usually quite a bit higher. In hot climates it is often too high for good market-egg quality and may be above the safe range for hatching eggs.

The maximum cooling that can be obtained by an evaporative cooler is the wet-bulb depression, and consequently such coolers are most useful in arid climates. One disadvantage in their use, when the diurnal temperature variation is large, is sweating. Eggs will condense whenever the dew point is above the egg temperature, and since in the high humidity of such a cooler the dew point is nearly as high as temperature itself, sweating conditions often occur during the morning temperature rise.

Considerations such as the above led to interest in mechanical refrigeration as a

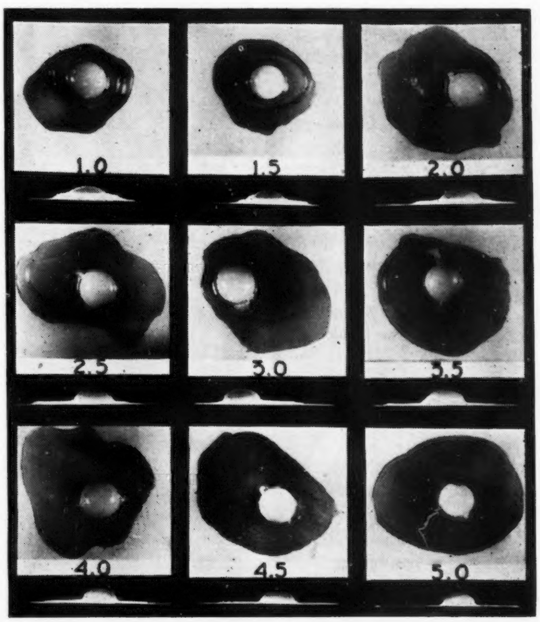

Fig. 1 Albumen score standards (Van Wagenen, Hall and Altmann[1]) illustrating variation in albumen quality

This paper was presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Davis, California, January 17, 1945.

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* Superscript numbers refer to appended references.

AUTHOR'S ACKNOWLEDGMENT: The investigation reported in this paper was supported by the California Committee for the Relation of Electricity to Agriculture and has been a cooperative project. Acknowledgment is due to Professor B. D. Moses and to K. F. MacIntire, R. A. Kepner, J. S. Gelders, H. L. Belton, and H. D. Lewis who worked out the engineering features, and designed and built the experimental boxes.

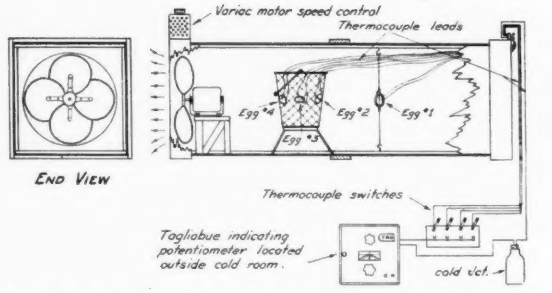


Fig. 2 Tunnel A used for obtaining cooling rates of eggs under different conditions

means of cooling and holding eggs on the ranch. Mechanical refrigerators can be designed to maintain almost any set of conditions that might be desired; the most important problem was to decide what conditions would be optimum and then to design a practical cooler that would approximate them.

Egg Cooling. With mechanical refrigeration the speed of egg cooling can be controlled over a wide range; consequently, since little information was available on this subject, egg-cooling rates and their effects on egg quality were studied before the design of the cooler was undertaken.

Funk[6] measured egg-cooling rates by means of a thermocouple inserted in the center of the egg, but his data were not general enough nor extensive enough for the present purposes. In the present study the same technique was used to determine the cooling rates of individual eggs and of eggs in various places in a wire basket. Eggs were cooled in still air and in air blasts of various velocities.

When the difference between egg temperature and air temperature was plotted against time, all cooling rates yielded straight lines on semilogarithmic paper. These curves can be defined by the general expression

$$t = \frac{C \log_{10} \Delta_o / \Delta_t}{V^a} + K$$

where Δ_0 and Δ_t are the differences between egg temperature and room temperature at the start of cooling and at time t, respectively; V is the air velocity, and K is a small correction due to irregularity at the start of the run. C is constant for a definite place in an airstream of defined characteristics; it is considerably smaller for eggs upstream than for eggs downstream to the air flow. The exponent a was found to have the value 0.6 for the egg in the middle of the basket, but is somewhat lower (down to 0.4) for an isolated egg or for an egg that is upstream to the air flow. However, the bulk of the eggs is probably represented fairly well by the center egg, and consequently a working formula that gives a fair approximation to the time in hours required to cool a basket of eggs from any temperature to 1 F above air temperature is

$$t_1 = \frac{C \log_{10} \Delta_o}{V^{0.6}}$$

For comparison of different rates, $t = H \log_{10} \Delta_o/\Delta_t$ or $t_1 = H \log_{10} (100{-}R)$, where R is the temperature of the cooling room and $H = C/V^{0.6}$.

H is the time required to cool an egg to one-tenth of the difference in temperature between egg and room. C varies considerably, primarily as a reflection of the cooling efficiency of the circulating air. This is illustrated by the results obtained in the two cooling tunnels. The tunnel A was open at both ends and had inside dimensions of

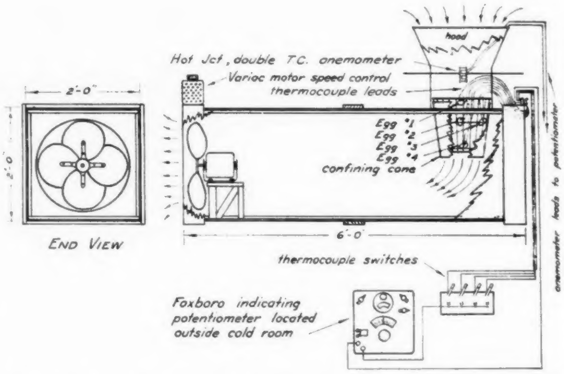


Fig. 3 Tunnel B used for determining the egg-cooling rates by forcing air to pass through the egg mass

2x2x6 ft. A 19½-in four-blade fan with a full-range variable-speed control drew air through the tunnel. A wire egg basket 10 in high by 12 in top diameter and containing 12 dozen eggs was used. A single egg was also suspended in a wire saddle in the center of the tunnel. The arrangement is shown in Fig. 2. The design and arrangement of tunnel B is shown in Fig. 3; it had the same dimensions as tunnel A but the inlet end was blocked off and a hole was cut in the top rear section to accommodate a confining cone of sheet iron. Into this cone the basket of eggs was placed. Thus all air passing through the tunnel first passed down through the basket of eggs. Both tunnels were operated in a constant-temperature room. The value of C for the center egg was 56 when eggs were cooled in tunnel A but was 19 for eggs cooled in tunnel B.

The effects of air velocity and of "effective velocity" are illustrated in Table 3. The value of H for the center egg in the basket was 9.0 to 9.5 hr for eggs cooled in still air; in tunnel A an impinging velocity of 500 fpm reduced H to 1.7 hr and 900 fpm reduced it further to 1.1 hr. In tunnel B air velocity was much more effective; 58 fpm reduced H as much as did 500 fpm in tunnel A, and less than 300 fpm reduced it to 0.6 hr. Cooling was also more uniform in tunnel B than in tunnel A. The extreme range of cooling rates (usually the difference between the upstream and downstream egg) varied up to 4.0 hr in tunnel A, but the maximum difference was 0.9 hr in tunnel B (Table 3).

Effect of Cooling Rate on Egg Quality. No information was available in the literature on the effect of cooling rate *per se* (i.e., independent of final temperatures) on egg quality. Two apparently contradictory beliefs were commonly held in the field: (1) that the more rapidly the

TABLE 3. EFFECT OF AIR VELOCITY ON EGG-COOLING RATE

Impinging velocity, fpm	H* (center egg), hr Tunnel A	H* (center egg), hr Tunnel B	H* (extreme range), hr Tunnel A	H* (extreme range), hr Tunnel B
0	9.5	9.0		
58		1.7		0.9
100	4.2		4.0	
113		1.2		0.4
168		0.9		0.2
200	2.8		2.1	
228		0.7		0.1
290		0.6		0.1
350	2.1		1.9	
500	1.7		1.4	
700	1.3		1.1	
900	1.1		0.9	

*H is the time required to cool an egg to one-tenth of the difference in temperature between egg and room.

eggs are cooled the better will be their quality, and (2) that too rapid cooling damages quality. Consequently, a series of experiments was undertaken to determine whether either of those two beliefs might be correct for each of the two important quality characteristics, shrinkage and albumen quality, or whether they might both be correct; i.e., whether an optimum rate might exist.

Shrinkage or evaporation loss, especially, might be expected to be influenced by too rapid cooling, at least when this is brought about (as in the present instance) by high air velocity, since high velocity at humidities less than 100 per cent promotes the evaporation of moisture. Shrinkage was measured on several lots of 12 dozen eggs each. Warm eggs (carefully selected for sound shells) were placed in a cooler (similar to tunnel B) within one hour after being gathered and were weighed periodically during the following three days. The resulting weight losses are summarized in Table 4.

TABLE 4. WEIGHT LOSS OF EGGS UNDER VARIOUS CONDITIONS

H, hr	Air temp. F	Relative humidity, %	Weight loss in 3 days, gram per egg
2.3	56	63	0.27
2.3	56	48	0.43
6.7	56	63	0.33
2.3	75	63	0.50
6.7	75	63	0.53

Average egg weight = 61g

Contrary to expectation, the least evaporation occurred when the cooling rate was the fastest. It would have been of considerable theoretical interest to extend these data in both directions, but the factors affecting weight loss were so clearly shown by these figures that further consideration of weight loss was delayed until studies could be made in the completed cooler. Air humidity was undoubtedly a factor, as was rate of cooling and final egg temperature; thus, the higher the humidity, the greater the cooling rate and the lower the final temperature, the less was the moisture loss.

Interior quality failed to show significant trends with cooling rate in preliminary studies; consequently, this relation was subjected to an exhaustive investigation. Here, however, a special cooling technique had to be devised to permit the cooling of eggs one or two at a time. Cooling rates similar to those of eggs in a full basket were desired, and individual eggs cool too fast for such comparison even in still air, yet individual eggs had to be used for the following reasons: (1) trapnested birds were necessary—the effect of bird individuality on albumen quality is so great that experimental results might otherwise easily be obscured; (2) since the eggs had to be cooled as soon as they were laid, one to a few eggs at a time had to be handled separately during the day.

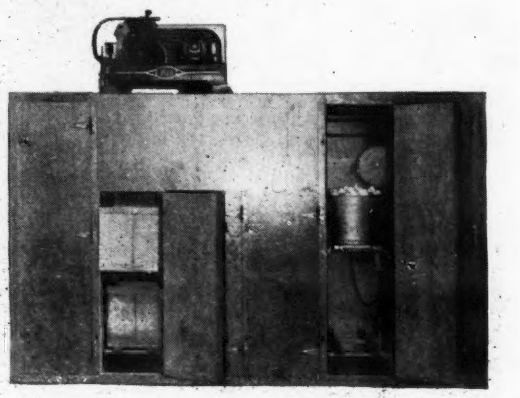


Fig. 4 Experimental egg cooler in operation. Doors open to show egg baskets and cases in place

Therefore, to simulate practical conditions the eggs had to be insulated to slow down their cooling rates. This was done with a series of six boxes. Box 1 was made of wire screen. Boxes 2 to 6 were made of sheet metal and had four compartments, each large enough for a single egg. Boxes 3 to 6 had, respectively, 1/2, 1 1/2 and 2 in of Celotex insulation. The cooling curves of eggs in these boxes were shown to be of the same form as for eggs in baskets.

Eggs were collected from trapnested birds every 15 min during the day and were immediately placed in one of the series of insulated boxes, prewarmed to 100 F. If less than 4 eggs were obtained from the traps, the extra spaces were filled with prewarmed "ballast eggs." Next morning the eggs were transferred to cases and stored in the same room for 3 more days; they were then broken out for quality measurement. Several eggs from each bird were also broken as soon as laid to obtain a measure of the bird's "fresh quality" for comparison. Albumen quality was estimated by measuring "albumen height".[7] This measurement is highly correlated with albumen score but is more sensitive and more objective.

Additional eggs were held in an incubator at 100 F for 2 hr before being placed in the cooling boxes. This was done in order to obtain an estimate of the effect of a moderate delay in gathering eggs from the nest.

The results, obtained from 1,500 eggs, show that differences in cooling time (t_1) over a range of 3 to 25 hr had no effect on albumen quality. When plotted against fresh quality of eggs from the same hens, the points fit a straight line; and constants of these lines (Table 5), obtained by least squares fitting, are essentially the same regardless of the cooling rate. Even a delay of 2 hr at start of cooling had no effect.

Candling appearance (as measured with the P.E.P. transparent yolk shadow scale No. 7[5]) was apparently slightly affected by the cooling rate. The average increase in yolk shadow (Table 5) tended to a minimum at the middle of the range of cooling rates studied. However, an analysis of variance, designed to minimize spurious effects due to variations in initial yolk shadow, showed that variance due to difference in cooling rate was only slightly greater than the experimental error, and consequently no confidence can be placed in these differences. A delay in start of cooling was, however, apparently effective in causing an additional darkening of the yolk shadow.

TABLE 5. INFLUENCE OF COOLING RATE ON INTERIOR QUALITY

H,	Albumen height constants*				Yolk shadow†	
	Immediate		2-hr delay		Increase	
hr.	*a*	*b*	*a*	*b*	Immed.	Delay
1.7	−0.87	0.84	−1.05	0.84	0.13	0.32
3.5	0.09	0.71	−0.84	0.81	0.01	0.25
6.8	0.64	0.67	−0.26	0.75	−0.01	0.17
9.4	−0.51	0.79	0.19	0.67	0.12	0.28
10.9	0.11	0.69	−0.22	0.96	0.11	0.15
14.6	−0.48	0.75	−0.28	0.72	0.15	0.44
Ave.	−0.17	0.74	−0.41	0.79	0.09	0.27

* a and b are constants of the expression $(AH)_f = a + b\,(AH)_i$, where $(AH)_f$ and $(AH)_i$ are initial and final values, respectively, for albumen height of eggs from the same hen. Values of $(AH)_f$ are for eggs 4 days old including the cooling time; those of $(AH)_i$ are for 15-minute-old eggs.

†Yolk shadows estimated by comparison with P.E.P. transparent shadow scale No. 7, from 1, a barely visible shadow, to 9, a dark red-orange shadow.

These findings showed that there was a wide range of cooling rates from which to choose consistent with maximum egg-quality maintenance, and thus the problem of cooler design was simplified.

Design of the Cooler. A cabinet-type cooler was selected for study, since with mechanical refrigeration a cabinet would be more economical to build and operate than would a room. This cabinet was designed to be used with a 2,000-hen flock from which eggs are delivered twice a week; it has space to cool 4 baskets of eggs at a time and storage space for 11 cases. The cooler as built is illustrated in Fig. 4; Fig. 5 is a schematic sketch to show arrangement of the cooler and path of the air circulation.

Eggs are collected directly from the nests into the baskets described below and these are placed on the cooling shelf where they remain until the eggs are to be packed or until they must be removed to make way for subsequent collections. Where eggs are packed once a day only, this shift is usually necessary; those collected earlier are stored temporarily after cooling in one of the case compartments. All empty cases are stored in the cooler as soon as received to precool them before they are packed.

The operating temperature chosen was 55 F. This is optimum for hatching eggs (Table 2), but it is considerably higher than the optimum for market eggs (Table 1); however, it is a more reasonable temperature for farm egg storage than lower temperatures would be. When eggs are to be held for a few days only, the additional expense of cooling to cold-storage temperature would probably not be economical; furthermore, if the eggs are cooled to below the dew point of the outside air, they will sweat when removed for shipment. (The summer dew point of the interior valleys of California usually varies around 55 F.) Also, 55 F can be maintained readily by a relatively small unit without frosting the coils, and this feature is highly desirable from the standpoint of maintaining a reasonable humidity in the cabinet and of operational convenience.

EGGS ARE COOLED MUCH MORE EFFICIENTLY IF ALL AIR IS FORCED THROUGH THE BASKETS

A ¼-hp compressor unit with a small (12x12-in, 2-row) evaporator coil will maintain the desired conditions if it is operated with a considerable air flow past the coil. Eggs are cooled much more efficiently if all of the air is forced through the baskets (see Table 3), but to do so might increase the pressure drop through the cabinet more than a small radial fan could handle. Consequently, it was thought necessary to compromise and by-pass a portion of the air. This was done by building a cooling shelf perforated with 100 one-inch holes of which 8 are under each basket. The baskets are made of sheet metal with hardware cloth bottoms and thus make their own confining cones. They are made from standard 3-gal water buckets.

The compressor is operated intermittently, controlled by a thermostat with a 2-deg range, but the fan operates continuously. The coils condense a little moisture, but do not frost, and the moisture is evaporated again when the compressor is not running. The box maintains a relative humidity of about 75 per cent.

The total air flow through the loaded cabinet is 360 cfm; approximately 25 cfm flows through each basket, and these values are almost independent of the loading pattern (i.e., of the number of baskets of eggs being cooled). The cooling rate is also affected only slightly by the loading pattern; *H* for an egg in the center of the basket varied from 1.8, when four baskets were in place, to 2.1 when three positions were empty (Table 6).

The forms of these cooling curves are slightly at variance with those discussed above, and the rates are somewhat faster than had been contemplated due to the fact that the thermostat is located downstream of the cooling shelf; introduction of warm eggs causes the compressor to operate an abnormally long time, and the cooler temperature is temporarily reduced by an additional 2 F, approximately.

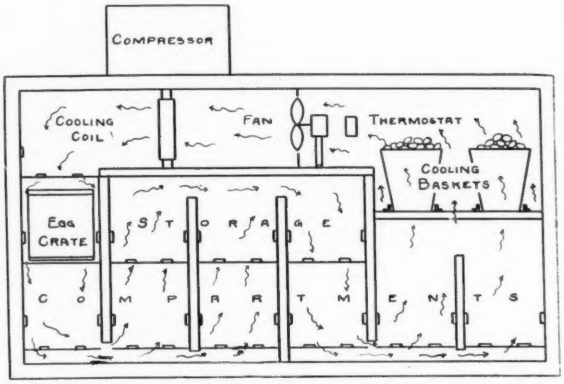


Fig. 5 Diagram of experimental egg cooler showing position of coils and direction of air flow.

Moisture loss of eggs in the experimental cooler was determined by weighing baskets of eggs as they were collected from the nests, and again just before they were packed in cases. After three days the same eggs were removed from the cases and weighed again. Since both humidity and cooling rate were somewhat more favorable for retarding evaporation than the best conditions studied above (Table 4), weight loss in the experimental cooler might be expected to be quite small. As a matter of fact, it was negligible. The average loss during the cooling period was less than 0.02 g per egg, and the greatest loss averaged only 0.08 g for the eggs in one basket. After being packed in cases, the eggs lost no perceptible weight. Meanwhile, the cases gained an average of 250 g during the three-day period whether they were packed or empty.

After completion of the field test (see next page) the possibility of further increasing the cooling rate by more efficient utilization of the circulating air was investigated. This was accomplished by redesigning the cooling shelf. The new shelf contains four holes, each 5½ in square over which the egg baskets are placed (Table 5). Shutters are fitted over the two rear holes and each shutter is drawn forward by a spring to cover the opening. As a basket is pushed into position over a rear hole, the shutter is pushed back; these positions are used only when there are three or four baskets in the cooler.

This shelf reduces the total air flow through the cabinet to 330 cfm, but the air flow through each basket is materially increased to about 40 cfm. The cooling rate is also appreciably increased; *H* for the center egg averages 1.0 (Table 6).

TABLE 6. COOLING RATES IN EXPERIMENTAL COOLER

Shelf design	Loading pattern	H for eggs in various places in basket, hr: Upstream	center	Side center	Downstream
100 holes	1 warm basket + 3 cooled baskets	0.5	1.8	1.9	2.8
	1 warm basket	0.9	2.1	1.8	2.5
4 holes	1 warm basket + 3 cooled baskets	0.5	0.9	0.9	1.5
	1 warm basket	0.5	1.1	1.0	1.5

Field Test. The cooler was installed on a commercial poultry ranch of about 6,500 birds, located about 50 miles from the receiving station. Eggs were divided into two groups as collected from the nest, one group being placed in the experimental cooler and the other being handled according to the method the owner used previously.

The egg room that was used as a control was a well-constructed insulated room equipped with a forced-draft evaporative cooler. Eggs were collected in metal pails, cooled on the floor of this room, and packed in cases that had been precooled in the same room.

Continuous records of temperature were obtained in the cooler, in the owner's egg room and in the building in which both were housed. Power consumption of the cooler was also recorded.

During the period of the field test, the daily maximum temperature in the feed house varied from 46 to 109 F and in the egg room from 47 to 79 F. The cooler was set to run at 55 F. Temperatures as high as 60 F were occasionally recorded for a short time after warm eggs were introduced, but since the thermometer was placed between the cooling shelf and the coils, this temperature was not characteristic of the cabinet as a whole. As a matter of fact, during this time the main part of the cabinet was cooled about 2 deg below the usual running temperature (see above). Average temperatures for the six months, May through October, inclusive (obtained by integrating the temperature curves), were 72 F in the feed house and 63.8 F in the egg room. Thus the average temperature in the cooler was about 9 deg lower than that in the evaportive cooler room and 17 deg lower than that in the feed house during the warm months.

During the period August 28, 1942, to July 8, 1943, 647.5 cases of eggs were cooled using 819 kw-hr. This is equivalent to 2.6 kw-hr per day, 1.27 kw-hr per case, or 0.042 kw-hr per dozen. This provided cooling at rate of 2.06 cases per day and storage of about five days, but since the compressor was run only about 37 per cent of the time, the load could have been increased. The unit under these conditions should handle 3⅔ cases per day, and store them for three days.

SEPARATE CANDLING RECORDS OF EGGS HANDLED BY TWO METHODS WERE MADE

Separate candling records of the eggs handled by the two methods were made at the receiving station. Dirty and checked eggs were eliminated from consideration to avoid confusing the results with defects not related to the cooling method. During one three-week period in August and September, 555 dozen eggs were cooled in the experimental cooler and 1173 dozen were held in the egg room. Of the large clean eggs held in the cooler 52.7 per cent were graded AA, 39.1 per cent A, and 8.2 per cent B; the corresponding grades obtained for egg-room eggs were 31.5, 49.4 and 19.2 per cent, respectively. The grades of medium and small eggs had similar distributions.

At the prevailing prices an additional income of $7.61 was obtained from clean eggs cooled in the experimental unit. During this three-week period, the power cost of operation was $1.81 which left a net extra income for the three weeks of $5.50.

A more exact comparison was obtained by breaking eggs held in these units and examining them for interior quality. One day each week for six weeks one case of freshly gathered eggs, obtained each time from the same group of birds, was candled and divided as equally as possible on the basis of candled quality into two lots. One lot was cooled in the experimental cabinet and held there for four days. The other lot remained in the evaporative cooler room for the same period. The eggs were then candled again and broken out for quality measurement. The results are summarized in Table 7.

The average grade of all these eggs was considerably better than the grade reported above for eggs sent to the receiving station. This was partly due to a shorter interval between removal from the cooler or egg room and grading, and partly, perhaps, to the different candlers. Primarily, though, it was due to the fact that in the latter trial eggs were carefully selected; no eggs that would have been graded down due to shell abnormalities were included. Thus all eggs below grade AA were placed in the lower grades only because of interior quality conditions.

TABLE 7. COMPARISON OF QUALITY OF EGGS HELD 4 DAYS IN REFRIGERATED COOLER AND IN EVAPORATIVE COOLER ROOM

Cooler	No. of eggs measured	Distribution by grade, per cent			Albumen score	Albumen height, mm
		AA	A	B		
Refrigerated	1037	82.9	14.0	3.1	2.4	5.25
Evaporative	1086	73.5	23.9	2.6	2.7	4.97

The difference reported in grade (Table 7) represented an extra 2.8 dozen AA eggs per case of eggs cooled in the refrigerated cooler. This is a striking difference, especially when it is realized that the comparison is with an evaporative cooler of a type that represents some of the best egg-cooling equipment in common use at present. Had the comparison been made with eggs held in the feed house (as they are on many ranches) the difference would have been even more striking.

This difference in grade reflected an actual difference in opened egg quality. The average albumen score was 0.3 units better in the refrigerator, and the average albumen height was 5.25 for eggs held in the experimental box as compared to 4.97 in the evaporative cooler room.

SUMMARY

1 Studies were made on the rate of temperature loss from eggs, and a general expression was obtained relating cooling rate to air velocity under various conditions.

2 Rapid cooling was shown to minimize moisture loss from eggs; however, albumen quality was not affected by the cooling rate within wide limits.

3 A refrigerated egg-cooling cabinet was designed, suitable for use on a poultry ranch of moderate size. When operated at 55 F appreciable improvements in egg quality were obtained over the quality of eggs cooled and held in an evaporative cooler egg room.

REFERENCES

1 Van Wagenen, A., G. O. Hall and M. Altmann. Proc. VII World's Poultry Congress 516 (1939), temperature and humidity in the short-time holding of eggs.

2 Funk, E. M., and H. V. Brillier. Poultry Sci. 23, 538-40 (1944), the minimum temperature for embryonic development in the domestic fowl (Gallus domesticus).

3 Scott, H. M. Poultry Sci. 12, 49-54 (1933), the effect of age and holding temperature on hatchability of turkey and chicken eggs.

4 Dougherty, J. E. Am. J. Physiol. 79, 39-43 (1926), studies in incubation I. The effect of low temperatures previous to incubation on hatchability of eggs set.

5 Lorenz, F. W., and W. E. Newlon. Poultry Sci. 23, 418-430 (1944), a field survey of ranch egg quality.

6 Funk, E. M. Missouri Agr. Exp. Sta. Bull. No. 350 (1935), the cooling of eggs.

7 Wilgus, H. S. Jr., and A. Van Wagenen. Poultry Sci. 15, 319-321 (1936), the height of firm albumen as a measure of its condition.

Agricultural Drainage and Land Use Problems in the Southeastern Region

By A. Carnes
MEMBER A.S.A.E.

AGRICULTURAL drainage has contributed to increased crop production and good land use in the Southeast. In most cases, land that needs drainage has no erosion problem. The flat wet land, after drainage, may be cultivated safely and intensively. In many cases, the adjacent uplands can be devoted to land uses commensurate with their productive capacity.

The U.S. Soil Conservation Service has developed a classification of land according to use capability, as determined by a study of the physical conditions on any given area. Recommendations can be made for the use of the land to maintain the production of from moderate to high yields of adapted crops and at the same time decrease the danger of further deterioration.

The classification of land according to its use capability affords a scientific method of determining not only the desirability of undertaking new drainage projects, but also of rehabilitating old drainage works from the standpoint of the agricultural uses that can be made of the land to be benefited.

The 1940 drainage census shows that there are 1,236 organized drainage districts, including 10,770,818 acres, in the southeastern region, comprising the states of Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. A substantial amount of this land needs improved drainage, which can be secured only by rehabilitation of outlet drains and the construction of adequate farm drains. The capital invested to 1940 represents an expenditure of $87,451,459 to provide major outlet drains in these districts. This cash outlay was made by landowners in the various drainage enterprises. In addition to the acres in organized drainage districts, it is estimated that there are 9,000,000 acres of potentially good agricultural land that needs drainage improvement.

Approximately all of the drainage facilities referred to above were designed and constructed by trained engineers in the period 1915 to 1925. As a result of research and field observations, many new techniques of design, construction, maintenance, and feasibility determinations have been developed since 1925. These, along with other factors, make it desirable to rehabilitate many of the old community drainage systems to provide adequate drainage outletting. Spoil disposal and utilization, adequate berms, side slopes of ditches, maintenance, drainage coefficients, and the incorporation of soils information in planning have materially refined the redesign of existing drainage facilities. The lack of maintenance, in too many cases, has made rehabilitation necessary.

In the majority of cases, good field drainage was not established because trained engineers were not available locally to do the layout work. Without placing emphasis on completing the job, farmers believed that the major outlets were all that were necessary to get drainage. The large ditches were constructed, yet farmers continued to have crop failures. The maintenance-tax levies were rejected and major outlets deteriorated. The removal of excess water and lowering of water tables were emphasized and the exact potentialities of the soil material itself were practically neglected. The lack of suitable equipment or a knowledge of the use of dynamite in field ditch construction also delayed completing the field drainage job. Therefore, the full use and benefit of the major drains were never realized.

With the rapid organization of soil conservation districts in the southeastern region during the past few years, technical assistance is now available to farmers in these districts in solving individual farm drainage problems as a part of complete soil and water conservation plans for their farms.

In the rehabilitation of old systems, a thorough study of land use capability should be made to determine whether additional expenditure can be justified on the entire system or whether the system should be redesigned to benefit only that land which is worth draining.

The overdrainage of organic soils, especially in the Everglades of Florida, has resulted in excessive subsidence and the actual burning of soil. Here again the major objective in drainage was to remove excess water without regard to the soil material and the resulting effect on cultivated crops and subsequent soil management. The overdrainage of inorganic soils has been observed in Florida and along the Atlantic seaboard. These possibilities should be considered when the system is designed and provisions made for water retention to effect controlled drainage. Overdrainage of organic or inorganic soils will result in decreased crop production and difficult soil management.

New Community Systems. In planning farms for soil and water conservation, undrained land is found on many farms. Frequently it is necessary for two or more farmers to use the same outlet. This requires cooperative effort on the part of these farmers in providing main outlets for field ditches or tile systems. Where only a few farmers are concerned or the acreage benefited is small, it may be unnecessary to organize a drainage district. In such cases a mutual nonprofit association may be organized whereby rights-of-way, ingress and egress, and maintenance, may be provided and assured.

A drainage canal that needs maintenance

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Birmingham, Ala., February, 1946.

A. CARNES is chief, regional engineering division, southeastern region, Soil Conservation Service, U. S. Department of Agriculture.

The understanding between the farmers should be in writing and should be recorded with the respective land deeds. In the case of property changes, the new landowner will automatically become a member of the association and the common facilities will continue to serve the community. The maintenance clause should specify annual maintenance contributions for each farmer, or each cooperator should be responsible for maintaining a particular section of the ditch. If the community system is located in a soil conservation district, local drainage specialists are available to advise what annual maintenance is necessary.

Where a large number of farmers and large acreages are involved, it is desirable to organize a drainage district under state laws.

For all proposed community drainage jobs, the following procedure has been found desirable in soil conservation district operations:

1 Make a soil conservation survey of the area to be drained. From these data the acreage suitable for row crops and pasture can be determined. An estimate of yields, after adequate drainage has been established, can be made. From crop production records the benefits of drainage can be estimated.

2 The preliminary engineering surveys should include sufficient physical data to determine approximate locations of mains and laterals, cost of rights-of-way, clearing, excavation, and annual maintenance. From these estimates and the indicated benefits, the feasibility of the work can be determined.

3 These preliminary plans and estimates should be presented to the local group of farmers. If they can raise the funds to proceed with the job, detailed engineering surveys and plans, including specifications, will be made before construction starts.

After the major drainage outlet facilities have been provided, the field drains must be planned, constructed, and maintained. In this connection the purpose of a field drain should be thoroughly considered. Is it desired to remove surface water or is it necessary to lower the water table? What crops are to be grown and how much drainage is necessary for the particular crop? The substitution of tile for open ditches will help to increase the size of fields, thereby making it easier to apply mechanized production methods. Tile drainage, where feasible, also eliminates annual cleaning of ditch banks and adds acres for crops. In certain truck-growing sections along the Atlantic coast line, it is estimated that open ditches take 15 per cent of the land area.

Maintenance. All structures and soil conservation practices require maintenance to protect the original investment. Drainage ditches or tile systems are no exception. Natural vegetation begins to cover the sides of ditches as soon as construction is completed. Silt begins to drift into new ditches with the first rains. Eroded material from the drainage basin washes into the ditches. All these tend to retard flow in the ditches. The silt-contributing areas should be located and the land use changed to stabilize such areas. Road ditches discharging into canals should be stabilized to prevent bar formation at the discharge point. Therefore, it is evident that both maintenance provisions and preventive measures should be provided in the original plans for all drains.

It has been found in the delta area of Mississippi that kudzu on the banks of canals will control willows and other undesirable vegetation. In the case of clean-outs, equipment can be driven over the kudzu, thus eliminating the expensive cost of clearing in advance of clean-outs. Under certain conditions, Bermuda grass, with the assistance of mowing, will help to control undesirable vegetation and stabilize the cut slopes. Mowing ditch banks two or three times a year will usually control the undesirable vegetation.

The most important thing about maintenance is that the work shall be done at the time when the need arises. "A stitch in time saves nine." A systematic schedule for inspection of ditches should be provided to determine what needs to be done and then do the work. For community ditch systems, one individual should be responsible for inspecting and directing the maintenance work. Such individuals should have the authority to proceed to do the needed work on a force account or contract basis.

Where the drainage districts are large, or where several districts are in a county, it has been demonstrated that the employment of a full-time engineer with equipment, maintenance crews, and repair facilities, is most economical for good maintenance operations. Such an organization has been set up for several drainage districts in Washington County, Mississippi, under R. H. Pedigo, chief engineer. His annual report for 1938 and 1939 shows the economy of such a maintenance organization.

The major drainage problem areas in the southeastern region and the most difficult engineering problems associated therewith are:

1 The drainage of old rice fields and the tidal marshes along the Atlantic coast line. Outletting against tides and the diking out of salt water are the major problems.

2 The flatwoods of the Coastal Plain. The most difficult engineering problems associated with this area are flat grades and deep sands.

Left: A drainage canal with good side slopes and spoil spread • *Right:* This picture shows a growth of kudza that is controlling willows and other undesirable vegetation on a drainage canal

3 The loessial section in the states bordering on the Mississippi River. Here silt control problems are outstanding.

4 The delta of the Mississippi River. The discharge of loessial silt from the hills above the delta and flat grades in the delta constitute the major technical problems of design and maintenance.

5 The valleys of the Piedmont and mountain section. Due to topography, the flash runoff requires larger drainage coefficients. It is not economical to construct channels to prevent overflow. Main channel improvement, including snagging and bar removal, diversion of hill water, and a drainage system on the bottomland are the main engineering problems.

6 Organic soils of the Everglades of Florida and along the coast of North Carolina. Closely controlled drainage systems to reduce subsidence and soil burning are the major problems to be solved in these areas.

The requests for drainage assistance from farmers in soil conservation districts throughout the region have increased since 1939. It is easy to understand why farmers are interested in good farm drainage when we study the statements of the soil conservation district cooperators about benefits to be derived from drainage. J. P. Bennett, Union County, Mississippi, states "Of the 300 acres benefited by our ditches, one-half of it has been in weeds and willows for the past five years. The increased crops from this area alone will be worth three times the cost of drainage in the crop year of 1945. This does not include the increased yields due to good drainage on the second half of the area."

W. E. Bennett of the same section states, "We had three rains this summer that would have ruined 75 per cent of our crops had we not ditched our land. The ditches worked perfectly in removing the excess water, and it looks as if we will make 3,000 bu of corn on 80 acres where one rain last year cut the yield to 1,000 bu. Only one time — a very dry year — in the past ten years have we made as much as 2,500 bu, and some years we did not even take the wagon to the field to harvest."

M. L. Few, Route 1, Kingstree, South Carolina, planted 16½ acres of tobacco on land that was not well suited to this crop prior to drainage, because of a high water table. Following the completion of drainage operations, Mr. Few planted all his tobacco acreage within the drained area. This year we have had approximately 30 days of continuous rains which have wilted or drowned a high percentage of the tobacco not having adequate drainage. Mr. Few stated that he will make approximately 1,200 lb per acre of cured tobacco on the 16½ acres and attributes a saving of 500 lb per acre to adequate drainage. None of his tobacco is wilted, whereas all his neighbors have suffered extensively. Using Mr. Few's figures, a saving of $3,465 resulted, based on an average of 43c per lb received for the tobacco. The total drainage job benefited approximately 450 acres and cost Mr. Few in the neighborhood of $6,000.

Frank Matthews of Lynchburg, South Carolina, testifies to benefits derived from a community drainage job. "In December, 1942, lateral H was completed by the Lynches River Soil Conservation District, cooperating with the Atkins Drainage District commissioners. This lateral changed the course of the water that formerly was flooding approximately 50 acres of my farm. This land would not produce crops in wet years and very poor crops in other years.

"Since the completion of this canal, I have made two good crops. On 28 acres I produced 55 bu of oats per acre. Lespedeza followed the oats and last year I cut 1½ tons of hay per acre. Three acres are now producing an average of a bale of cotton per acre. This land had never produced cotton before."

New Hydraulic Problems

By R. B. Hickok

AGRICULTURAL engineers have heretofore been concerned with hydrology mainly as a basis for their hydraulic designs of individual water-handling structures and systems. In the future, our primary concern with hydrology should be in the development of broad plans and programs for the maximum utilization and conservation of agricultural resources. There are several major hydraulic problems which will be of increasing importance and which agricultural engineers should be prepared to meet in the immediate future.

One of these is the adequacy of soil moisture for maximum crop yields. Readjustments in land use according to its capabilities, the development and adoption of improved strains and varieties and increased use of fertilizers will greatly increase the requirements for soil moisture to realize the maximum potential for increased yields and reduced unit costs of production. It will be necessary not only to develop methods for increasing moisture available to crops, but also to establish the ultimate probabilities of moisture deficiencies for various levels of production which might determine the economic limit on intensified production effort.

Another very urgent problem is that of adequate farm water supply for modern domestic requirements for livestock, irrigation, spraying, and for farm processing and manufacturing. We have passed in a relatively few years from a land of virgin forests and prairies to a land of highly developed agriculture and industry. The result has been greatly reduced rates of recharge of ground-water supplies and vastly increased pumping. More or less critical farm water supply problems now exist in many sections of the country and may be expected to become much more serious unless properly analysed and unless remedial measures are taken. There seems to be general failure to recognize the enormity and urgency of this problem, probably because of its rapid development and the cyclical fluctuations in ground-water levels which have obscured their downward trend and given unjustified hopes of natural improvement. Undoubtedly the adoption of soil and water conservation practices on a nation-wide basis will produce important improvement in ground-water levels. However, it must be recognized that no new hydrologic balance based on intensive exploitation of the land and pumping of ground water can ever restore the ground-water levels and normal stream flows of the past.

Agricultural engineers must be concerned with evaluating the effects on ground-water recharge rates of such agricultural influences as (1) reduced infiltration of rain into the soil and its percolation to ground-water storage, with intensive cultivation and changing soil conditions, (2) increased evapotranspiration losses with cropping, and (3) the interception of vertically moving free water through the soil and its diversion to surface streams by subdrainage. From sound estimates of ground-water recharge rates and of agricultural water supply, the following requirements must be determined: (1) the extent to which ground-water supplies must be supplemented by surface-storage reservoirs and stream diversion to meet anticipated demand, and (2) the physical and economic limitations on development of supplemental supplies, and accordingly the long-range water supply prospects of particular sections and localities and its anticipated imposition of economic limitations on their agricultural development.

Discussion at the fall meeting of the American Society of Agricultural Engineers, Chicago, Ill., December 7, 1945.

R. B. HICKOK is a project engineer (research), U. S. Soil Conservation Service.

Engineering Farm Chore Jobs

By H. J. Gallagher
MEMBER A.S.A.E.

FOR the past 21 years, I have been actively interested in the fascinating problem of engineering farm chore jobs. Our best results, however, have never quite compared with those of an older brother on the farm, because time after time I have witnessed the older brother engineer all of the farm chores on a younger brother, and as yet we haven't been able to do that with electricity.

It was 21 years ago that the national Committee on the Relation of Electricity to Agriculture (C.R.E.A.) embarked on the crusading and pioneering venture of the electrification of agriculture. About all it had to offer, with the exception of the advantage of electric lamps over kerosene lamps, water pumping and a few domestic operations, was an idea, a vision; and visionary projects requiring the expenditure of vast sums of money, time and effort are extremely difficult to promote. This is especially true when the project is national in scope and contains a multiplicity of interests such as rural electrification contained. There were the interests of the manufacturers and distributors of electric energy, the interests of the rural users of electric service, the interests of the manufacturers and distributors of electrical equipment and appliances, the interests of research workers in adapting electric service to farm practices, and the interests of educators to take the story of agriculture to the electric companies and equipment manufacturers as well as to take the story of electric operation to the farmer. The coordination of those various interests into a practical, workable pattern was a colossal task that was most ably accomplished by the C.R.E.A. in its early years of existence.

An original objective of C.R.E.A. was to recognize rural electrification as an economic problem — that it would cost money on the part of electric companies to extend rural service, that it would cost the farmer money to wire his buildings, purchase equipment, and pay his electric bills, and that each group was entitled to a tangible return on its respective investment. This of course meant that electricity had to pay its own way, that it couldn't be an additional expense on the farm in the form of a luxury, but that it had to become a new farm tool that would replace other and costlier methods of converting a farmer's time and labor into profitable enterprises. The most natural and fertile field of attack to accomplish that purpose was in those time-consuming and labor-consuming operations known as farm chores. Farm chores, especially on farms where poultry or livestock is involved, are one of the most characteristic things of farm life as they are a part of each and every day's existence, requiring attention the first thing in the morning and the last thing at night, and with frequent occurrences throughout the day.

How much time a farmer spends doing chores on a farm is something I don't know. There are some six million farms in the United States, and it is conceivable that each would furnish a different answer. Statements we've all heard—that a farmer spends some 50 per cent of his time doing chores on an average farm—have little if any meaning because there is no such thing as an average farm.

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Illinois, December, 1945, as a contribution of the Rural Electric Division.

H. J. GALLAGHER is farm service supervisor, Consumers Power Company.

The time spent in doing chores on a 200-acre Wisconsin dairy farm cannot be compared to the time spent in doing chores on a 2,000-acre wheat ranch in the wheat belt. The former instance might require 80 per cent of the farmer's time, and the latter might involve no chores.

Generally speaking, however, chores are a definite part of the operation of the large majority of our farms. The nature of chores and the time and labor involved vary widely according to the type of agriculture adapted to different geographic divisions of the country, and also to the different types of agriculture practiced within each geographic division. The burden of chores is the heaviest on farms having livestock and poultry, and the more varied the livestock program, the more time and effort required for chores. This is especially true where dairy farming is involved.

If we had before us a map of the United States showing the rural areas of electric distribution, we would find that the greatest saturation of rural service was in those areas where the kind of agriculture practiced involves a lot of farm chores, the exception being the far west where electric power is extensively used for irrigation purposes, which could hardly be classed as a farm chore. There are many reasons why the progress of rural electrification has followed the pattern it has, but the most fundamental reason, in my opinion, is what electric service could do in reducing the time, effort, cost and drudgery of the daily tasks of farm chores.

To enumerate the daily chores that are now being done by electric operation on a dairy farm, a poultry farm, a stock farm, or almost any other kind of farm for that matter, would take longer than my allotted time, nor is it necessary before a group of this kind where most of you can recite these different uses as readily as you can recite the alphabet. The alphabet, however, remains constant at 26 letters, while electric uses for doing farm chores are added to and improved each year. Many of these uses are initiated by the farmer himself, and others are the result of studied research.

I have already said that one of the early objectives of the C.R.E.A. was to consider rural electrification as an economic problem from which a farmer could expect a tangible return on his investment, and then I glibly continued in terms of time saved and labor saved—two old standard expressions extensively used to evaluate electric service. In reality, the mere saving of either time or labor may not be an economic asset from which a farmer receives a tangible return on investment—it can easily become a luxury or economic liability. We recently checked a farm that is about to get electricity. At the present time they have 12 milch cows, 7 head of young stock, 3 brood sows, 3 horses, and 125 hens. The cows are now being milked by hand in the light of kerosene lanterns; the stables are cleaned by the wheelbarrow method. In fact, the entire routine of chores is done in the good old-fashioned way and requires some six hours per day. Within a week or two service will be available on this farm, and Mr. Farmer has big plans about how he is going to make electricity save him time and labor. He has already purchased a small hammer-mill feed grinder and a 10-gal dairy water heater; he has contracted for a pipe-line milker and insists he is going to have a gutter cleaner because, as he expressed it, he hated hand milking and stable cleaning worse than

poison. He has it all figured out—and with substantial figures—that he can reduce his labor 50 per cent and save 4 hr a day doing chores. The cost of the equipment mentioned is $1,210, which doesn't include wiring costs. At the present time he has the money and is willing to make that expenditure to relieve himself of two obnoxious chores and do his work faster. Well, our company will appreciate that additional load on our lines, but if that is as far as our interest went we would have an unhealthy and an unsound rural program because this farmer is not thinking of electricity as a means of increasing production, lowering operating costs or improving the quality of product, any or all of which have a direct bearing on net revenue. He is viewing it only as a convenience. Our responsibility as rural representatives is to sell service on the basis of not merely saving time but of providing more time for additional farm chores or for performing some other profitable enterprise that will increase net revenue, with conveniences and comforts thrown in for good measure.

THE FARMER SELLS HIS TIME TO THE FARM AND COLLECTS PAY BY DOING NEEDED WORK

I have always remembered a statement made by the dean of agriculture during my senior year at Michigan State College. His statement was to the effect that a fundamental feature of farming was that a farmer sells his time to the farm and collects his pay by performing the duties demanded. At the time I thought that was an odd distortion of fact; since then I've learned to appreciate the wisdom of that statement, which of course is equally true of other occupations besides farming.

To return to the farmer who is going to cut his chore time from 6 to 2 hr a day, it is obvious that as a farmer he should continue to sell those 4 hr back to the farm and thus collect more pay. Just how he does that presents a problem. The answer may be in increasing the size of his dairy herd or his poultry flock, or it may be in venturing into new enterprises that he formerly didn't have time for. All this will call for additional investments beyond that required for electrical equipment. This kind of problem cannot be solved by any set formula. It's the kind of a problem that offers electric companies unlimited opportunities to be of service to agriculture by maintaining a staff of trained farm representatives to advise and assist farmers in the proper use of electric service. A large majority of the electric companies that serve farms have already availed themselves of this opportunity and the results have been highly satisfactory.

During the war period, we all witnessed the conversion of time to production. Farmers were asked to produce more than they had ever produced before—to produce more with less machinery, to produce more with less help, less help not only from conscription for military service but from high-wage competition in the war industries. Despite these handicaps, quotas were not only made but time and again they were exceeded. Agriculture accomplished that goal in the same manner industry accomplished its miracle of munitions production—it put electricity to work. Without electric power neither industry nor agriculture could have approached those goals. In making that statement I have a full appreciation that less than 50 per cent of the farms of the country have electric service. But if we could again refer to a national map on electric distribution, we would find the most extensive service is in those areas that annually produce the bulk of the nation's total food supply.

The war test of electricity on the farm was a tough test, but it met that test in a gallant manner. And now in this postwar period it has to meet another tough test, possibly an even tougher test. Among the most immediate and pressing problems confronting agriculture will be that of cutting production costs. Farm prices will surely decline, but if production efficiency can be made to keep pace with price reduction but little loss will occur in farm net income. Many factors can contribute to this, but time and labor-saving equipment will be the greatest. Since production of labor is measured by time, anything which cuts time permits greater production by labor.

Of course, all this reference to the relation of time, labor, efficiency, production and revenue will be recognized as a recitation of the creed of agricultural engineers. However, when viewed electrically this creed gains new significance for the following reasons:

1 The annual amount of chore time on a large majority of our farms materially exceeds the time required for tillage and harvesting.

2 The best time-saving, or preferably the best time-providing, agency ever available to agriculture is electricity.

3 Postwar plans by both the business-managed and the REA cooperatives assure rapid extension of service into unserved rural areas within the next three years.

4 The low cost of electric power.

5 The large number of chore processes that have already been adapted to electric operation.

6 The large number of plans already in development to establish new uses for electricity on the farm and to further perfect those already in use.

7 The future development of uses and applications that aren't even dreamed of today.

In conclusion, I like to think of electricity in terms of a mine sweeper—something that will keep the agricultural pathway ahead clear of monotony, drudgery, hardships, inconveniences, and costly, inefficient, time-consuming, labor-consuming methods of operation.

Call It "Hay Finisher"

TO THE EDITOR:

I WOULD like to urge that you use the term "hay finisher" in AGRICULTURAL ENGINEERING when referring to the mow-curing process.

When we undertook the study in the Tennessee Valley, we knew all about the high-temperature driers such as the Arnold drier and the Mason and Fulmer tunnel driers which use high temperatures and cost from $5,000 up. Practically all these driers take freshly cut hay from the field and dry it at high temperatures.

In undertaking the development of a low-cost hay curing system for average farms, we realized that probably the best idea would be to remove as much moisture as possible in the field in one day's time, and then finish the curing in the barn. The mow hay finisher was the result.

Since the people developing high-temperature driers have been using the term "hay drier" for many years, I think we should avoid that term for the sake of clarity, and so that we do not mislead farmers into thinking they can put freshly cut hay into their mows with "hay drier" results.

I did not succeed in getting the term "hay finisher" unanimously adopted at the A.S.A.E. barn hay-curing conference at Purdue University last month, but a number of those in attendance — D. G. Womeldorff, R. C. Shipman, J. B. Stere and others — are going to use it. That term is correct, and I think the best way to get it used is to use it.

GEO. W. KABLE

Editor, Electricity on the Farm Magazine

Professional Agricultural Engineering Service for Farmers

To the Secretary of A.S.A.E.:

DURING the fall meeting of the American Society of Agricultural Engineers at Chicago last December, I was interested in comments on a subject to which I have given considerable thought; they applied particularly to the advancement of professionl agricultural engineering including its recognition by other branches of professional engineering.

One thought expressed was that other recognized branches of engineering were a little reluctant about giving agricultural engineers "the nod", that is, recognizing them as being on the same level as the older branches of engineering. Another thought was that there should be more professional agricultural engineers to serve farmers out in the farm communities.

I think it a fair question to ask how the agricultural engineer located in a rural community would be expected to earn a livelihood. I would assume that drainage and structures would generally offer the principal opportunity for engineering service. However, the U.S. Soil Conservation Service is engaged in drainage work, and the various state agricultural extension services furnish professional engineering service in farm structures, in so far as their limited staffs permit. There is evidence, however, of a general desire and intention to expand these staffs considerably. It would therefore seem advisable that those individuals who would risk entering the professional agricultural engineering field fortify themselves with architectural, civil engineering, or other engineering work so as to broaden the scope of their business in order to survive the competition of engineering services rendered by public service agencies.

In my experience in the professional engineering field, and in active association with structural, refrigeration, electrical and civil engineers and architects over a good many years, I don't recall a single instance where a business man went to the college in his or another state and received gratis a set of plans prepared to meet his individual needs. Why the needs of farmers should be viewed in a different light is difficult to understand. Agriculture has certainly come a long ways in mechanization and in increasing the amount of farm work that can be done per worker. Along with this has come a greatly reduced farm population, and it is generally felt that the farmer is in a particularly strong financial position at this time.

Frankly I see only a very limited field of opportunity for the professional agricultural engineer, unless he has the backing of the state college, and unless the use of professional service by farmers is encouraged by the agricultural extension service of the entire country. The farmer is not going to pay for professional service if he can get it for nothing. It has been said that there are not enough engineers trained for this field. I think such arguments can be discounted nearly 100 per cent if the opportunities are present. The field is not attractive under existing conditions; that is, the opportunities are not there.

One of the most fertile fields for the professional agricultural engineer and technician would be that of soil erosion control. Thousands of men have received training and experience in the Soil Conservation Service. Many of these men are returning from the armed forces. The work in the soil conservation districts and on farms generally could and would be done more effectively and efficiently by private professional technicians rather than through federal or state agencies. Furthermore, the farmer might be weaned away from the mesmerism of having his life and business planned for him in the form of a planned economy or socialized farming which seems to be the trend of thinking in some government agencies. Naturally the more planning that is being done by a governmental agency, the more indispensible it is assumed to be by its promoters. I am fully aware of the benefits and necessity of soil erosion control, but I am not so convinced of the need of an ever-expanding government organization to perform all the functions of the program.

For the better advancement of the field of the professional agricultural engineer, I suggest the following:

1 The A.S.A.E. should alert its membership to encroachments by political or other groups on the private engineering field so that Society members may act to protect their interests. Recently a congressman introduced a bill to furnish applicants for federal farm loans with free appraisal service. The American Society of Farm Managers and Rural Appraisers, through their executive board, advised its members of what was taking place and of their opinion of the measure. The members were advised to write and tell their congressmen and senators and the chairmen of congressional committees handling the bill that there was already in existence a group of professional rural appraisers, trained and capable, now doing this type of work. The response from the members of Congress has been quite gratifying.

2 The colleges and extension services can greatly aid our profession and create endless opportunities for it by recognizing the place of the agricultural engineer and the service he can render the farmer. It seems illogical to train a man for a profession and then compete with him.

3 I believe it is generally true that the colleges which have done the most research have received the most public acclaim. The agricultural engineering departments certainly have a wide-open field in research. The recent conference at Purdue University on barn hay-curing certainly emphasized this fact. Active research is indeed an indication as to whether an institution is dynamic or static. I feel that extension activities should be confined to work of a general nature, and not include personal service.

4 I feel that the services of the Soil Conservation Service should be confined to research and general studies and recommendations of practices and programs to be followed. As previously stated the programs could and would be more economically developed and put into effect on individual farms by the professional technician rather than through a governmental agency. At the present time this field affords the greatest opportunity for the returning technician that I know of, from the professional angle. Certainly the SCS should not undertake to compete with the professional drainage or irrigation engineer or technician.

I have a good many friends in college agricultural engineering work, as well as in the SCS. These comments are not made as a criticism of their efforts and the work they have been performing. They have given real service to agriculture and the farmer. I feel, however, that the farmer has grown up and does not need to be catered to as an underprivileged or peasant class. He can and should pay for engineering services and not receive advantages that are not accorded to other groups of people. The professional agricultural engineer can become a potent factor in the more efficient planning and operation of the farm if he is given the opportunity to perform those services in agriculture that his brother engineers perform for industry and business.

CARL R. OLSON

Owner, Olson Management Service

NEWS SECTION

Missouri Section Authorized

ON petition of a group of members of the American Society of Agricultural Engineers — most of them residing at Columbia, Missouri — the Council of the Society has authorized the organization of the "Missouri State Section", which shall automatically include within its membership all A.S.A.E. members residing in the state. The new section will devote its attention mainly to problems and questions confronting the agricultural engineers of that state, and to advancing their professional interests.

Wickard Maps Rural Electrification Program

IN a talk before the January 11th meeting of the Washington (D. C.) Section of the American Society of Agricultural Engineers, REA Administrator Claude R. Wickard (Hon. Mem. A.S.A.E.) stated the goal of the Rural Electrification Administration as complete electric service for every rural community and outlined the need for electric service and the great demand for extension of rural power lines. He pointed out that this country is a long way from the halfway point in providing rural electric service and the longest line mileages still remain to be constructed. He stated that there is need for increased capacity and for expansion in the utilization in electricity. He discussed the point of how much electricity can or should be used profitably by farm people and brought out the fact that labor shortages are forcing farmers to a greater degree of mechanization. It was his thought that, to make most sufficient use of labor and produce better farm products, the farm must be thought of more as a factory. He drew attention to the need of many more rural electrification specialists to assist farmers in the profitable utilization of electricity.

W. J. Riddell of the Soil Conservation Service, who recently returned to civilian life from the American Military Government service in Southern Italy, gave the Section a brief but interesting picture of agriculture in that area.

A total of fifty-nine members and non-members of the Society attended the meeting.

Wiring Handbooks

OFFERING comprehensive guidance to anyone planning farm wiring layouts, is the "Handbook on Farmstead Wiring Design," a 64-page book to be published in March of this year by the Industry Committee on Interior Wiring Design, representing ten leading trade associations and technical societies, most of them in the electrical field. The handbook covers interior wiring for every farm building, showing recommended locations for convenience and lighting outlets and branch and feeder circuits. Exterior distribution systems are discussed at length, as are pole and outdoor metering. Tables and data on demands, wire sizes, and voltage drop are also included.

The Industry Committee is also publishing (in February) the "Handbook of Residential Wiring Design," a 32-page booklet which is a complete revision of the residential standards appearing in the 1937 handbook.

Both handbooks are the result of over a year's planning and preparation by a joint committee representing the following organizations: American Institute of Electrical Engineers, American Home Lighting Institute, American Society of Agricultural Engineers, Edison Electric Institute, Illuminating Engineering Society, International Association of Electrical Inspectors, National Electrical Contractors Association, National Electrical Manufacturers Association, National Electrical Wholesalers Association, and Radio Manufacturers Association. The A.S.A.E. was represented on the joint committee by M. H. Lloyd, agricultural engineer, Buffalo Niagara Electric Corp., and C. P. Wagner, manager of farm service department, Northern States Power Co. Mr. Lloyd also served as chairman of the group preparing the farmstead handbook. The farmstead handbook will sell at 40 cents per single copy and the residential handbook for 25 cents per copy, and at greatly reduced prices in quantity lots. Orders for either handbook should be sent direct to Industry Committee on Interior Wiring Design, Room 2650, 420 Lexington Ave., New York 17, N. Y. (Copies of the residential wiring handbook may be obtained at 10 cents per copy from A.S.A.E., St. Joseph, Michigan, as long as the Society's limited supply lasts.)

A.S.A.E. Meetings Calendar

February 13 and 14 — SOUTHEAST SECTION, Thomas Jefferson Hotel, Birmingham, Ala.

February 26—PACIFIC COAST SECTION, Sacramento, Calif.

June 24 to 27—ANNUAL MEETING, New Jefferson Hotel, St. Louis, Mo.

December 16 to 18 — FALL MEETING, Stevens Hotel, Chicago, Ill.

Personals of A.S.A.E. Members

Jack W. Adair was recently discharged from service with the U.S. Navy, in which he attained the rank of lieutenant (jg), and is now employed as an agricultural engineer with the U.S. Soil Conservation Service at Hugo, Okla. His work will include planning, layout, and supervision of construction of terraces, ponds, drainage and all water-control activities in the district.

Henry E. Berns, who during the war was employed as an instructor in naval air technical training, also in the testing division of an aviation engine plant, recently accepted employment as service manager, at the Batavia, N.Y., branch of the Massey-Harris Company.

Gustav H. Bliesner, assistant agricultural engineer, State College of Washington, is the compiler of "1945 Irrigation Demonstrations Notes" prepared especially for the Western Washington Reclamation Institute cooperating with the Washington Agricultural Extension Service and the U.S. Department of Agriculture. Mr. Bliesner is also author of Extension Mimeograph 342, issued by the Washington Agricultural Extension Service on rural electric applications as a 4-H Club activity.

James S. Boyd, who served 22 months as engineering officer on a diesel mine sweeper during the war, obtaining the rank of lieutenant (jg), has been separated from the USNR and has accepted a teaching position on the agricultural engineering staff of South Dakota State College.

John C. Bursik, who served in the U.S. Naval Reserves during the war with the rank of ensign, has received his discharge and has returned to his former position on the agricultural engineering staff of Oregon State College.

Walter M. Carleton, who served in the U.S. Naval Reserve during the war, is now on terminal leave with the rank of lieutenant (j.g.) and has started work for a master of science degree in agricultural engineering at Iowa State College.

R. Barry Cecil, who served as a captain in the Army Air Forces during the war, is a civilian again and has accepted employment as a farm production specialist with the General Electric Supply Corporation at Nashville, Tenn.

John M. Chambers, until recently in the engineering department of Harry Ferguson, Inc., at Detroit, has been transferred to the company's organization located at Coventry, Warwickshire, England.

Myron G. Cropsey, who served in the Army during the war, attaining the rank of major, is now a civilian again, and has accepted a position on the agricultural engineering staff of Oregon State College at Corvallis.

Capt. Robert M. Dill, who has been serving with the Quartermaster Corps of the Army, Winchester, Kans., has been transferred to the Quartermasters Subsistence School at Chicago.

T. S. Forseith, who served as a lieutenant in the Royal Canadian Engineers during the war, has been discharged and is now engaged as agricultural engineer, specializing in soil and water conservation, at the Dominion Experimental Station at Swift Current, Sask.

K. R. Frost has resigned as assistant professor of agricultural engineering, University of Idaho, to accept the position of associate agricultural engineer, New Mexico Agricultural Experiment Station at State College.

Roy W. Godley has resigned as head of the rural department of the Monongahela Power Company, to become rural sales manager of Edison Electric Institute, with headquarters at 420 Lexington Avenue, New York. *(Continued on page 84)*

Personals of A.S.A.E. Members

(Continued from page 82)

R. G. Harvey, who has been in charge of rural electrification in the Syracuse district of the Central New York Power Corp., was recently promoted to the position of rural service supervisor for the entire company and will have charge of rural electrification promotion for all of the company's seven districts.

Arlon G. Hazen, formerly a member of the agricultural engineering staff of the University of Arkansas, and who has just been released from active duty with the Army as a colonel of the Corps of Engineers, has accepted the appointment of irrigation engineer on the agricultural engineering staff at North Dakota Agricultural College. He will be stationed at Lewiston, North Dakota, and will devote his time to irrigation and other agricultural engineering research in the western part of the state.

G. E. Henderson has been advanced from assistant chief to the position of chief of the Agricultural Engineering Development Division of the Tennessee Valley Authority, succeeding C. J. Herd.

Etlar A. Henningsen, who served in the Field Artillery branch of the Army during the war, attaining the rank of captain, has become a civilian again and has accepted placement in the progressive students' course at the McCormick Works of the International Harvester Company at Chicago.

Olin E. Hughes, who served in the U.S. Naval Reserves during the war, obtaining the rank of lieutenant (sg), and who previous to war service was engaged in sales work with the Caterpillar Tractor Company, in the Southeast, recently accepted the position of general manager of the branch of the general implement corporation at Atlanta, Georgia.

Curtis A. Johnson, who has been engaged in special hookworm eradication work for the Florida State Board of Health, has received appointment as assistant professor of agricultural engineering at the University of Delaware.

C. Rodney Johnson has recently been released from military service and has resumed his position on the agricultural engineering extension staff of Iowa State College.

Gerald A. Karstens, who has been connected with the Missouri River division office of the U.S. Army Engineer Corps, recently resigned to accept appointment as extension agricultural engineer at Purdue University and will specialize in soil conservation and drainage work.

Keith Q. Kellicutt, who has been serving as a civilian instructor in radio mechanics in the U.S. Army Air Forces, was recently released from this activity and has accepted the appointment of technologist at the Forest Products Laboratory of the USDA Forest Service, at Madison, Wis.

Donald M. Kinch, who a few months ago accepted a position as design engineer with Climax Engineering Company at Clinton, Iowa, was recently made assistant chief engineer in charge of the agricultural division and will have direct supervision of the future design and development of the Company's rotary tiller, known as the "Till-Master".

Albert W. Lavers was recently appointed chief engineer of the farm equipment division of Graham-Paige Motors Corp., in which capacity he will have charge of engineering for the Rototiller, the Frazer tractor and other farm implements. For nearly two years Mr. Lavers was administrative engineer of Harry Ferguson, Inc., and previous to that served twenty-six years with the Minneapolis-Moline Farm Implement Co. and its predecessor company as chief engineer of the automotive division in charge of tractor and engine design.

W. J. Liddell, who served as a first lieutenant in the Army Air Forces during the war, was recently released from military service and has returned to his former work with the research section of the U.S. Soil Conservation Service. He is to be associated with a cooperative project of the SCS and the University of Georgia and will be engaged in conducting investigations on supplemental irrigation in Georgia.

Frederick A. Lyman, who served as a captain with the Army Air Forces during the war, is again a civilian and has resumed his former position as account executive with the advertising agency, Fuller and Smith and Ross, Inc., at Cleveland.

Robert M. Magee, who served with the Army during the war, attaining to the rank of captain, recently returned to civilian status and is now employed in the sales department of the Moline Tractor Works of Deere and Company, and is located at Moline, Illinois.

J. S. Parker, who served with the Royal Canadian Engineers overseas during the war, attaining the rank of major, has returned to civilian life and is now associated with the Dominion Experimental Station at Swift Current, Sask.

Robert P. Smith, who has been general farm sales manager of Westinghouse Electric Supply Company at New York City, was recently appointed manager of the company's Midwest district with headquarters at St. Louis. *(Continued on page 86)*

Personals of A.S.A.E. Members

(Continued from page 84)

Ray M. Lien has returned to civilian life, after serving as a first lieutenant with the 319th Bomber Group of the Army Air Force, and is now engaged as instructor in agricultural engineering at South Dakota State College. He will also be engaged in part-time research work in the agricultural experiment station.

J. W. Martin, who has been serving with the U.S. Naval Reserves during the war, attaining the rank of lieutenant, (sg), has received his release and has returned to the former position he held of associate professor of agricultural engineering at Kansas State College.

E. A. Olson, who served as a captain in the Field Artillery of the Army during the war, is back in civilian life again, and has returned to his former position as extension agricultural engineer at the University of Nebraska. He will be specializing in farm structures and rural electrification work.

W. J. Ridout, Jr., who has just returned from service with the Navy during the war and who was previously rural electrification extension specialist at Clemson Agricultural College, has accepted appointment as agricultural engineering extension specialist in rural electrification at North Carolina State College.

James L. Shepherd, who was a major in the Army Air Forces during the war, and was formerly a member of the agricultural engineering faculty at the University of Georgia, has been discharged from the Army and has accepted a position with the Georgia Coastal Plain Experimental Station at Tifton where he will engage in research work in farm machinery.

Homer J. Stockwell, who has been in the Army during the war where he attained the rank of major, has received his honorable discharge and is now associated with the Division of Irrigation, Soil Conservation Service, USDA, and is engaged in snow survey work with headquarters at Fort Collins, Colo.

Monroe W. Treiman has been honorably discharged as a second lieutenant in the Army Air Forces and has returned to his general farming business near Brooksville, Florida.

D. E. Washburn, agricultural engineer, division of electrical development, Tennessee Valley Authority, calls attention to a publication, entitled "Farm Wiring Needs," which has been prepared by his division of TVA, and which was designed to create a desire for good farm wiring on the part of farm users of electricity.

Necrology

ELMER F. BRUNNER, development engineer in charge of work on tractor and implement tires for the Goodyear Tire and Rubber Company, passed away January 5 at the Cleveland Clinic following an illness of several months. He would have been 56 on February 5.

He was born February 5, 1890, in Salem, Ohio, and was graduated from Canton (Ohio) Technical School. He received his mechanical engineering degree from Carnegie Institute of Technology in 1913. The following year he joined Goodyear, working on mold and core design.

He was active in rim development from 1915 to 1924. At various periods Mr. Brunner was in charge of different sections in the development division, including specifications and inspections. In 1925 he became subdivision head in the tire development division, taking over development of solid tires, tubes, air bags and accessories, mold equipment design and specifications. He served in that capacity until 1935 when he was named farm tire development department head.

Mr. Brunner was active in some of the earliest tests when airplane airwheel tires were tried out successfully on steel-wheeled tractors in the citrus groves of Florida, early in the 1930's.

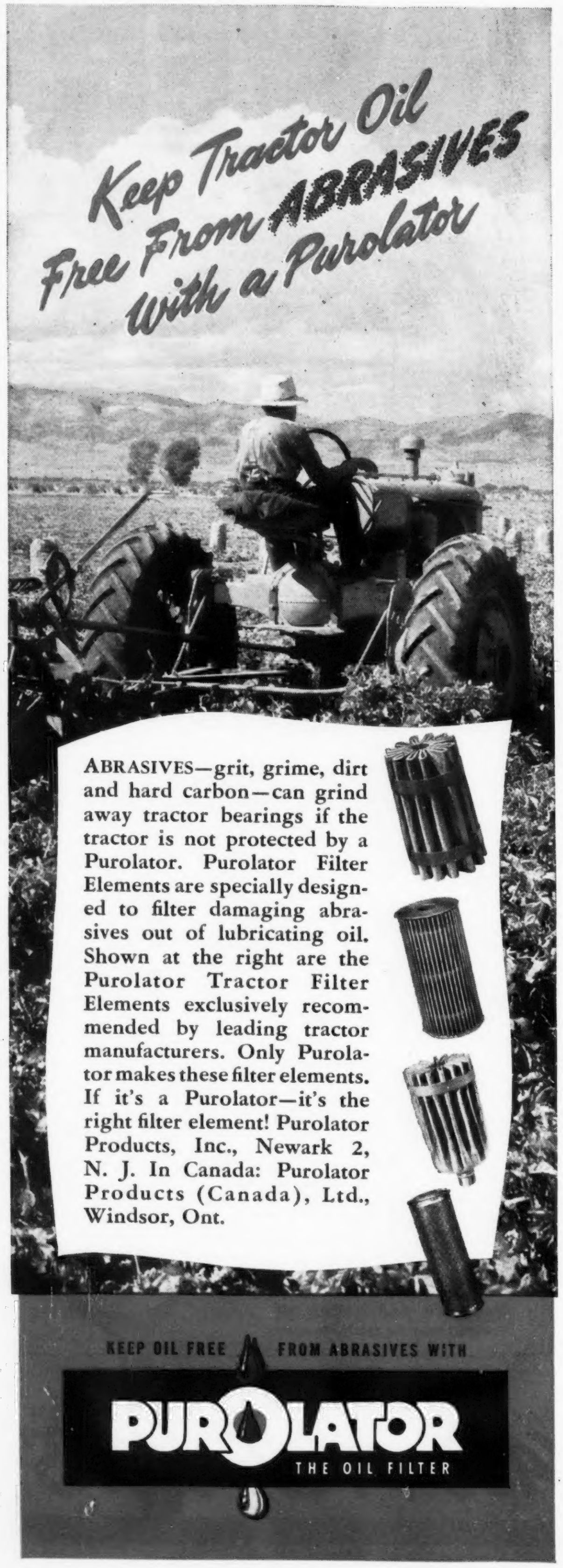
As manager of farm tire development, Mr. Brunner directed the research and design that was responsible for Goodyear's line of tractor and implement tires. He also sponsored the development of liquid inflation of tractor tires.

A member of the A.S.A.E. since 1936, Mr. Brunner was active in its Power and Machinery Division and in other organizations in furthering and coordinating the technical knowledge, development, and application of rubber tires for farm tractors and implements.

During the war emergency, Mr. Brunner devoted approximately half his time in serving as consultant for governmental agencies in Washington, including the rubber director's office of WPB and the War Food Administration.

He was a Knight Templar and a member of the Shrine.

Mr. Brunner is survived by his wife, Margaret, five daughters, his mother, three brothers and three sisters.



Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Clarence K. Beeman, graduate student, Iowa State College, Ames, Iowa. (Mail) 703 12th St.

Alvin T. Bell, farm owner and operator, Route 2, Vincent, Ala.

Henry E. Blatt, detachment of patients, Kennedy General Hospital, Memphis 3, Tenn. (Mail) Route 2, Box 175.

Fred C. Boles, agricultural engineer, Soil Conservation Service, USDA. (Mail) P. O. Box 243, Victoria, Tex.

O'Gorman M. Browne, farm specialist, General Electric Supply Corp., 326 W. Georgia St., Indianapolis, Ind.

Sven O. Dahlgren, district engineer, Soil Conservation Service, USDA. (Mail) Box 711, Coeur d'Alene, Idaho.

Lloyd S. Devoe, branch manager, J. I. Case Co., Atlanta, Ga. (Mail) 523 Stewart Ave., S.W. Atlanta, Ga.

Greville B. Harrison, farm buildings section, Dominion Experimental Station, Swift Current, Sask., Canada.

Cameron Hervey, associate editor, Farm Journal, Washington Square, Philadelphia 5, Pa.

Eugene E. Houck, designing engineer, The Oliver Corp. (Mail) 1126 Goodland Ave., South Bend 19, Ind.

Raymond J. McCune, owner, McCune and Company, New Waterford, Ohio.

Donald E. Milford, 1st Lt., Field Artillery, AUS. (Mail) Gunnery Dept., FAS OCS, Ft. Sill, Okla.

Vilas J. Morford, assistant professor of agricultural engineering, Iowa State College, Ames, Iowa.

Gordon L. Nelson, assistant, farm bureau, Portland Cement Assn., 33 W. Grand Ave., Chicago, Ill.

William R. Noble, Washington representative, National Retail Farm Equipment Assn., 1024 Vermont Ave., N.W.: Washington, D. C.

Robert R. Owen, engineer, California Packing Corporation, Honolulu, T. H.

Ralph E. Patterson, 583 N. High Street, Carrollton, Ohio.

Virgil C. Rathel, manager, farm production sales, General Electric Supply Corp., Ohio (Mail) 644 Greenwood Ave., Cincinnati 29, Ohio.

Charles A. Rollo, graduate student, Alabama Polytechnic Institute, Auburn, Ala. (Mail) 148 Burten Ave.

John P. Russell, distric manager, Detjen Corp. (Mail) 33 Vose St., Woonsocket, R. I.

Edward W. Sebold, farm production equipment specialist, General Electric Supply Corp. (Mail) 146 N. Third St., Columbus 15, Ohio.

Edward R. Smith, engineering draftsman, Starline, Inc. (Mail) 12 Mariette Place, Albany 2, N. Y.

Paul C. Venard, 1400 Central Ave., Hawarden, Iowa.

Reynolds E. Wallace, Jr., graduate student, Alabama Polytechnic Institute, Auburn, Ala. (Mail) 233 East Glenn.

Arthur Wenhardt, research on farm machinery, Dominion Experimental Station, Swift Current, Sask., Canada.

John J. Wolfe, chairman, agricultural tire simplification committee, The Rubber Mfrs. Assn., 444 Madison Ave., New York 22, N. Y.

TRANSFER OF GRADE

Walter L. Abney, soil conservationist, Soil Conservation Service, USDA. (Mail) Box 118, Greensboro, Ga. (Junior Member to Member)

A. Nelson Dingle, research associate in meteorology, Massachusetts Institute of Technology. (Mail) 71 Martin St., Cambridge 38, Mass: (Junior Member to Member)

Raymond C. Fischer, agricultural engineer, Allis Chalmers Mfg. Co., La Porte, Ind. (Mail) 310 Maple Ave. (Junior Member to Member)

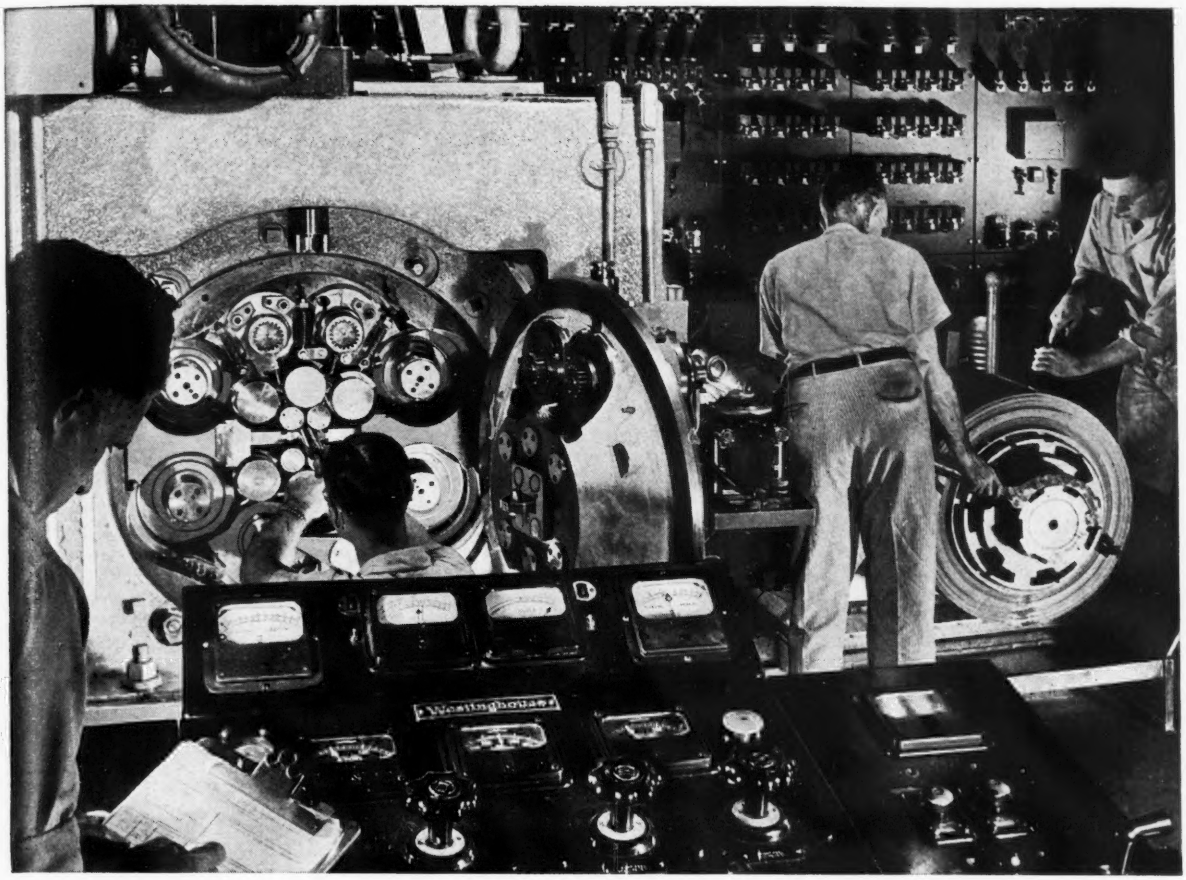
Donald M. Kinch, chief engineer, agricultural division, Climax Engineering Co., Clinton, Iowa. (Junior Member to Member)

Stanley M. Madill, executive engineer, John Deere Tractor Co., Waterloo, Iowa. (Associate Member to Member)

Robert J. McCall, Jr., assistant professor of agricultural engineering extension, Pennsylvania State College, State College, Pa. (Junior Member to Member)

Ross E. Voyles, captain AAF, AUS. (Mail) Sqdn. P., Chanute Field, Ill. (Junior Member to Member)

John C. Wooley, professor of agricultural engineering, University of Missouri, Columbia, Mo. (Member to Member)



Steel Sheets Thinner Than a Human Hair?

YES . . . and they'll soon have a lot to do with the every-day life of thousands of farmers.

These electrical steels — thinner than this sheet of paper — are being made on the Armco precision cold strip mill pictured above.

During the war they were used in combat walkie-talkies and radar equipment. The time is coming when you'll find these ultra-thin steels in fine radio receivers, tiny radio sets for communication between field and farmhouse, and other electrical devices.

These steels are one of the latest examples of research by Armco — long known as the leader in the field of special-purpose steels. Out of the Armco laboratories have come ARMCO Galvanized PAINTGRIP, ARMCO ZINCGRIP and other special sheet steels that mean better appearance and longer service for farm machinery and equipment.

As in the past, leading manufacturers of products for the farm are using steel that bears the famous Armco triangle trademark — for 32 years a dependable guide to quality in sheet steel. The American Rolling Mill Company, 741 Curtis Street, Middletown, Ohio. Export: The Armco International Corporation.

The American Rolling Mill Company ARMCO **Special-Purpose Sheet Steels**

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request.

The discharged veteran of World War II wears this emblem. Remember his service and honor him.

POSITIONS OPEN

LABORATORY TECHNICIAN for chemical analysis of feeds, etc. Midwest farm supply company. Salary open. O-412

EXTENSION AGRICULTURAL ENGINEER to specialize in farm buildings. Southern state college. Salary open. O-430

RURAL ELECTRIFICATION SPECIALIST for teaching and research. Southern state college. Salary open. O-434

SALES ENGINEER to contact and assist design engineers of farm machinery in design of power transmissions. New England power transmission manufacturer. Salary open. O-448

ASSISTANT OR ASSOCIATE AGRICULTURAL ENGINEER for research and teaching in irrigation, soil erosion, and land development work. Western state college. Salary, $3000 to $3600. O-452

DISTRICT MANAGER to make recommendations for and sell electric fly-screen installations in central New York state. Eastern manufacturer. Salary, $3000 to start. O-458

AGRICULTURAL ENGINEER for drafting, design, and development work on farm machinery. Eastern farm equipment manufacturer. Salary open. O-462

RESEARCH SCHOLARSHIP in connection with dairy barn research project. Midwest state college. Salary, $1100, with opportunity to carry up to 5 credits of college work. O-464

PROMOTION DIRECTOR to supervise and plan structures activities in farm and industrial fields. Location Chicago or New York. Some travel. Eastern trade association. Salary, $6000 to $7000. O-465

JUNIOR PROMOTION MAN (on farm structures) to prepare publicity, advertising, etc., and to work with colleges, 4-H clubs, etc., at Midwest location. Considerable travel. Eastern trade association. Salary, $3500. O-466

AGRICULTURAL ENGINEER to develop and design pumps and other farm implements. Western New York farm machinery manufacturer. O-469

RESEARCH FELLOWS (3) in agricultural engineering with opportunity to carry full-time graduate study leading to master's degree. Midwest experiment station. Salary, $540 for 9 months. O-470

COPYWRITERS (2) for tractors and tractor-mounted and tractor-driven implements and machines. Midwest farm machinery manufacturer. Salary $150 to $325 per month. O-471

FARM STRUCTURES ENGINEER to carry on extension work looking to improvement of farm housing and rural sanitation and to assist in design of concrete structures. Midwest trade association. Salary commensurate with experience and ability. O-472

SALES PROMOTION ENGINEER (writer) to collect material and then edit magazine for rural builders and farm leaders, as well as prepare other promotion literature. Midwest trade association. Salary commensurate with experience and ability. O-473

ENGINEER to design corn planters, grain drills, manure spreaders, harrows, and other farm implements to gradually replace present chief engineer approaching retirement. Midwest farm mach mfr. Salary open. O-474

TWO JUNIOR ENGINEERS to work on detail design of spray machinery including assistance in redesigning high-pressure pumps, guns, tanks, vehicles, and practically an entire new line of products. Midwest farm mach. Salary $2500 at start. O-475

ASSOCIATE EDITOR to write stories and do other editorial work on rural electrification trade publication. Eastern publisher. Salary $200 to $250 per mo. O-476

AGRICULTURAL ENGINEER for design and development of corn pickers. Midwest farm mach. mfr. Salary open. O-479

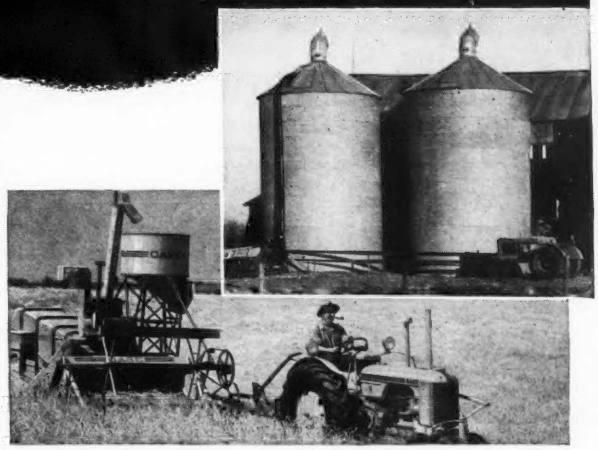
ENGINEER for design and experimental work on haying equipment. Midwest farm mach. mfr. Salary open. O-480

DESIGN ENGINEERS for work on farm tractors and component parts. Midwest farm mach. mfr. Salary $2400 to $4000. O-481

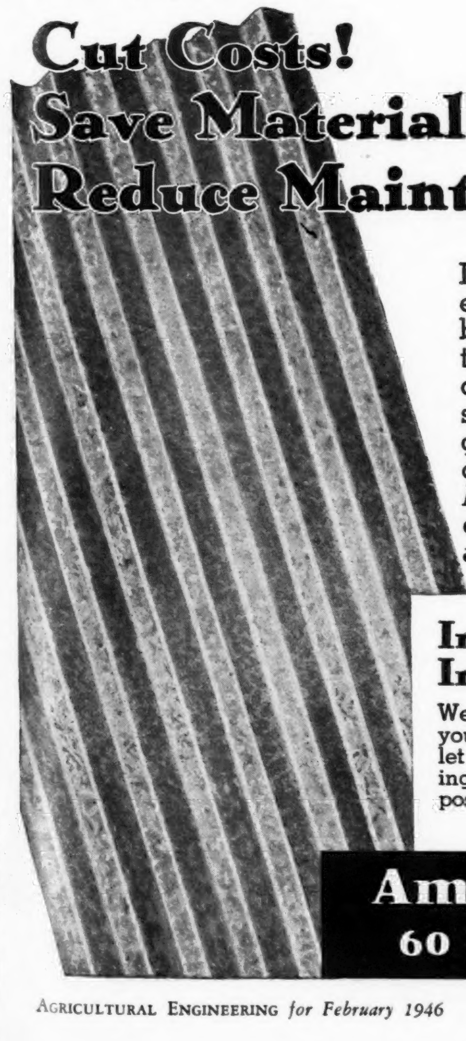
ASSISTANT EDITOR for semi-technical farm equipment trade journal. Established midwest publisher. Salary open. O-482

(Continued on page 92)

It's the ZINC *that Stops the Rust!*



ALL credit to steel, a staunch and strong building material! It's worthy of the best protection you can give it—and the U. S. Bureau of Standards says ZINC is "by far the best protective metallic coating for rust-proofing iron and steel"... So long as steel is coated with zinc, it can not rust; and since the life of a zinc coating is *at least* proportional to its thickness, the heavier the coating, the longer it will protect the underlying steel.



Cut Costs! Save Material! Reduce Maintenance!... with ZINC

It is sound sense and simple economy to use zinc wherever possible for the protection of iron and steel—in buildings, in equipment, in machinery. Good design that includes zinc-protected steel will cut costs, not only in the original saving of material but also in subsequent maintenance. Heavy zinc coatings insure greater durability and longer service life—that is a demonstrated scientific fact; so for economy, *specify heavy coatings.* They cost but little more, yet pay enormous dividends in greatly increased durability and reduced maintenance costs.

Interesting and Valuable Information About Zinc

We want you to know more about zinc. Won't you please send us your name and address and let us mail you, without charge, these interesting and valuable booklets? Your address on a postal will do.

American Zinc Institute
INCORPORATED
60 East 42nd Street, New York 17, N.Y.

PERSONNEL SERVICE BULLETIN

(Continued from page 42)

ENGINEERING ASSISTANT to agricultural manager of large western local chamber of commerce, for statistical and engineering consultant work in soil and water and flood control fields. Salary $3000 max to start. O-483

AGRICULTURAL ENGINEER (instructor - rank) for teaching physics and applied mechanics, and to conduct research in rural electrification. North central state university. Salary about $3000. O-484

ENGINEERS for conservation work with U. S. Soil Conservation Service. Entrance salaries, $2320 (P-1) and $2980 (P-2). (A.S.A.E will refer interested persons to appropriate SCS regional offices on request.)

POSITIONS WANTED

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, research, sales, or service work in power and machinery field, with private company. Age 26. War veteran. Salary $200 per month. W-200

AGRICULTURAL ENGINEER (B.S. deg) desires farm structures development, sales, or service work or product processing with either a private company or public agency. Age 25. War veteran. Salary $3000. W-201.

AGRICULTURAL ENGINEER (B.S. degs in AE and ME) desires design, development, or research work in farm machinery or farm structures, with private company or public agency. Age 30. Salary open. W-202

AGRICULTURAL ENGINEER (B.S. deg) desires sales or service work in farm machinery or project engineering in rural electrification with private company or public agency. Age 27. Salary $250 per mo. W-203

AGRICULTURAL ENGINEER (B.S. deg) desires sales or development work in farm machinery or rural electrification, with private company or public agency. Age 29. Salary $2400. W-205

AGRICULTURAL ENGINEER (B.S. deg) desires sales or design and development work in farm machinery with private company. Age 30. Salary open. W-206

AGRICULTURIST (B.S.A. deg, major in animal husbandry) with extensive experience in farming, farm management, marketing, and advertising, desires sales or advertising work in farm machinery, farm structures, or soil and water field with private company. Age 47. Salary $300 per mo. W-207

AGRICULTURAL ENGINEER (B.S.A. deg, major in ag eng) desires design, development, or sales work in farm machinery with private company or public agency. Age 25. Salary $3000. W-208

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, or research work in farm machinery with private company or public agency. Age 35. Salary $350 per mo. W-209

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, or sales work in farm structures or soil and water conservation, with private company or public agency. Age 28. Salary open. W-210

AGRICULTURAL ENGINEER (B.S. deg) desires design, research, or sales work in farm machinery with private company. Age 25. Salary $3500. W-211

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, sales or service work in farm machinery, soil and water conservation, or farm management, with private company or public agency. Age 24. Salary $2400. W-212

AGRICULTURAL ENGINEER (B.S. and M.S. degs) desires development or research work in farm machinery or farm structures, with private company or land-grant college. Age 36. Salary open. W-213

AGRICULTURAL ENGINEER (B.S. deg) desires sales or service work in farm machinery, with private company. Age 34. Salary $5000. W-214

AGRICULTURAL ENGINEER (B.S.A. deg, major in ag eng) desires sales or service work in soil and water conservation with private company; or agricultural engineering for a farm management organization. Age 27. Salary $2500. W-215

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, or research work in farm machinery or product processing, with private company or public agency. Age 30. Salary open. W-216

AGRICULTURAL ENGINEER (B.S. deg) desires sales or service work in farm building materials or equipment with private company. Age 34. Salary $3600. W-217

AGRICULTURAL ENGINEER (B.S. degs in both ag and ag eng) desires teaching and research work in farm machinery in a land-grant college; or sales or research with private company. Age 29. Salary open. W-218

AGRICULTURAL ENGINEER (B.S. deg) desires sales management or load building work in rural electrification, farm structures or product processing with private company or public agency. Age 28. Salary $3600. W-219

AGRICULTURAL ENGINEER (B.S. degs in both ag and ag eng) desires design and development work in farm machinery with private company. Age 32. Salary $3000. W-220

AGRICULTURAL ENGINEER (B.S. deg) desires design and development work in farm machinery with private company. Age 26. Salary $2500. W-221

AGRICULTURAL ENGINEER (B.S. deg) desires work in soil and water or farm machinery field with either a public agency or a private company. Age 25. Salary $1800. W-222

AGRICULTURAL ENGINEER (B.S. deg) desires research, development, sales engineering or service work in soil and water or farm machinery field with public agency or private company preferably in the Southwest. Age 25. Salary open. W-223

AGRICULTURAL AND CIVIL ENGINEER (B.S. deg in engineering and C.E. deg) with extensive experience, will be ready about June 15 to undertake new work in research, investigation, or consultation in the soil and water conservation field, for government agencies or private industry. Age 59. Salary $5000. W-224

PERSONNEL SERVICE BULLETIN

(Continued from page 92)

AGRICULTURAL ENGINEER (B.S. deg) desires development, research, service, teaching, or extension work in farm machinery with a private company or a college. Age 28. Salary $3250. W-225

AGRICULTURAL ENGINEER (B.S. degree) desires teaching and extension or research work in rural electrification or farm structures with public service agency. Age 27. Salary, $225 to $325 per month. W-226

AGRICULTURAL ENGINEER (B.S. degree in both Ag. and M.E.) desires design and development work in farm machinery field. Age 29, Salary, $350 per month minimum. W-227

AGRICULTURAL ENGINEER (B.S. deg) desires research and development work in farm machinery or rural electrification with private company or public agency. Age 26. $3000. W-228

AGRICULTURAL ENGINEER (B.S. deg) desires farm machinery sales and service work. Age 32. Salary $3000. W-229

AGRICULTURAL ENGINEER (B.S. degree) desires design and development or research work in farm structures or soil and water field, either private industry or public service. Age 35. Salary, $5000. W-230

AGRICULTURAL MACHINERY SALESMAN (B.S. deg in general business) desires sales work in farm machinery or farm structures field. Age 32. Salary $350 per mo. W-231

AGRICULTURAL ENGINEER desires design, development, research, sales or sales engineering and service work in farm structures field *only*, in either private industry or public service. Age 40. Salary, $4500 minimum. W-233

AGRICULTURAL ENGINEER (B.S. degree) desires sales engineering and service work in farm machinery field. Age 30. War veteran. W-234

AGRICULTURAL ENGINEER (B.S. degree) desires design and development work in farm machinery or farm structures field in either private industry or public service. Age 30. Salary, $3600. W-235

AGRICULTURAL ENGINEER (B.S. degree) desires research, design, or sales engineering work in rural electrification with private company or public agency. Age 30. Salary $3200 to $3600. W-242

AGRICULTURAL ENGINEER (B.S. degree) desires service or research work in rural electrification or farm structures field with private company or government agency. Age 28. Salary $200 per month. W-243

SALES REPRESENTATIVE, with 26 years' experience in implement and tractor fields, desires sales work with farm machinery company. Age 55. Salary open. W-246

AGRICULTURAL ENGINEER (B.S. degree) desires sales engineering and service work in power and machinery with private company. Age 30. Salary $200 to $250 per month. W-248

AGRICULTURAL GRADUATE (B.S.A. degree, major in ag eng and minor in physics) desires research, teaching, or extension work in rural electrification, farm structures, or soil and water field with state college. Age 44. Salary $2900 minimum for 9 months. W-250

AGRICULTURAL ENGINEER (B.S. degree) desires research, service or extension work in farm machinery, rural electrification, or soil and water field with private company, government agency, or college. Age 26. Salary open. W-252

LANDSCAPE ENGINEER, with several years experience with state highway department, REA cooperative on construction, and construction in soil and water field, desires sales or sales promotion work in farm structures or power and machinery field. Age 35. Salary open. W-254

AGRICULTURAL ENGINEER (B.S. degree) desires sales, sales engineering, or development work with private company in power and machinery or farm structures field. Age 31. Salary $3600 minimum. W-258

AGRICULTURAL ENGINEER (B.S. degree) desires design and development work with private company in farm machinery field. Age 30. Salary $325 to $350 per month. W-259

AGRICULTURAL ENGINEER (B.S. deg) desires work in rural electrn or in soil conservn with either private company or public service agency Age 25. Salary $3000 (min). W-260

AGRICULTURAL ENGINEER (B.S. deg in both agr and civil eng) desires design, development or research work (or hydrologic work requiring meteorological training and experience) in soil and water field with public service agency. Age 28. Salary $3000. W-261

AGRICULTURAL ENGINEER (B.S.A. and B.A.E. degs) desires work in functional design with private company or teaching and extension work in Midwest college in the field of farm mach or farm structures. Age 26. Salary open. W-264

AGRICULTURAL ENGINEER (B.S. deg) desires sales eng work in rural electrn or farm mach with private company. Age 29. Salary $250 per mo. W-267

AGRICULTURAL ENGINEER (B.S. in agr, major in agr eng) desires development, research or sales eng work with farm mach mfr, or project eng work in soil and water field with federal agency. Age 28. Salary $3500 (min). W-268

AGRICULTURAL ENGINEER (Both B.S. and M.S. degs) desires sales eng work in farm buildings or rural electrn fields with private company. Age 26. Salary $3600. W-270

AGRICULTURAL ENGINEER (B.S. deg in both agr and agr eng) desires sales eng and service work with farm mach company or irrigation or other soil conservation work with public service agency Age 27. Salary $250 per mo. W-271

AGRICULTURAL ENGINEER (B.S. deg) desires sales eng or research development work with farm mach company. Age 34. Salary $3500 (min). W-274

AGRICULTURAL ENGINEER (B.S. deg) desires work as development or project eng in product processing field. Age 28. Salary $3500. W-275

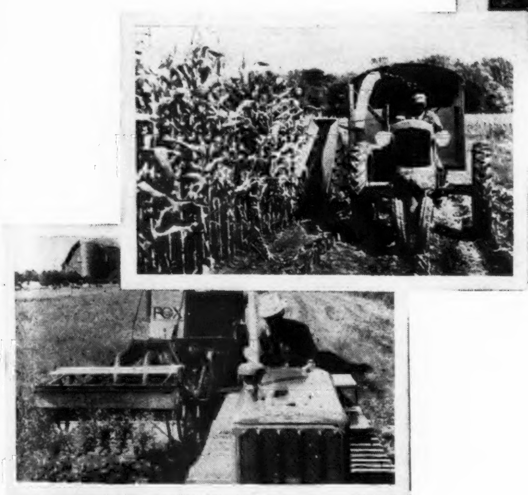
AGRICULTURAL ENGINEER (B.S. deg) desires design, development or research work with small power and mach company. Age 24. Salary open. W-276

(Continued on page 96)

The FOX *is a "Must"..!*

FOR THE FARM OF TODAY AND TOMORROW

THE FOX takes the backaches out of the farmer's three toughest hand labor jobs: Haying, Forage Harvesting, and Silo Filling. Only with the FOX are these three jobs properly mechanized.



With the FOX Pick-up Hay Cutter and Silage Harvester

—one man can pick up, chop and load, ready for the mow or stack, 2 tons of dry hay in 12 minutes.

—you can mow, chop and load, in one operation, over 200 tons of grass silage a day.

—cut corn of any height, chop it into silage and load it into wagons, ready for the silo, all in one operation.

The FOX is built by the Pioneers of Modern Forage Harvesting. WRITE US—we will be glad to tell you all about this marvelous machine.

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PERSONNEL SERVICE BULLETIN

(Continued from page 94)

CHEMICAL ENGINEER (B.S. deg) desires development or sales eng work in farm mach or product processing fields. Age 43. Salary $4000 to $5000. W-277

AGRICULTURAL ENGINEER (B.S. deg) desires development or research in rural electrn with private company or public service agency, or research or extension work in soil and water (irrigation) field. Age 27. Salary $2400 to $3000. W-279

AGRICULTURAL ENGINEER (B.S. deg) desires design or sales eng work in power and mach fields. Age 27. Salary $3000. W-280

AGRICULTURAL ENGINEER (B.S. deg) desires research or extension work with college or federal agency in power and mach or rural electrn. Age 27. Salary $2400. W-281

AGRICULTURAL ENGINEER (B.S.A. deg) desires development or research work in power and mach, farm structures, or rural electrn field with private company or federal agency. Age 32. Salary $3500 to $4000. W-282

AGRICULTURAL ENGINEER (B.S. deg) desires research and development work in farm mach with private company or college. Age 25. Salary $3000 (min). W-283

AGRICULTURAL ENGINEER (B.S. deg) desires design, development, sales eng or research work with farm mach company. Age 27. Salary $4000 to $5000. W-284

CHEMICAL ENGINEER (B.S. deg) desires development, research, or service work in product processing field. Age 34. Salary $2000 (min). W-286

AGRICULTURAL ENGINEER (B.S. deg) desires design, development or research work in farm mach or soil and water field with private company or federal agency. Age 23. Salary $2600 to $3000. W-287

AGRICULTURAL ENGINEER (B.S.A. and B.A.E. degs) desires design or research in farm mach field or research work in soil and water field. Age 27. Salary $4000. W-288

AGRICULTURAL ENGINEER (B.S.A. deg, with major in A.E.) desires sales or research work in power machinery or farm structures with private company in Florida. Age 38. Salary $3200. W-289

AGRICULTURAL ENGINEER (B.S. and M.S. degs) desires sales or service work in farm structures or power and machinery with private company in Virginia or North Carolina. Age 38. Salary $3000. W-290

AGRICULTURAL ENGINEER (B.S. deg) desires research, development, or sales engineering work with private company. Age 26. Salary $2500 to $3000. W-291

AGRICULTURAL ENGINEER (B.S. deg) desires power and machinery sales work. Age 28. Salary $3500. W-292

AGRICULTURAL ENGINEER (B.S. deg) desires power and machinery service work. Age 26. Salary $2400. W-293

AGRICULTURAL ENGINEER (B.S. deg) desires work in soil and water field. Age 30. Salary $2600. W-294

AGRICULTURAL ENGINEER (B.S. deg) desires development work in soil and water field with public agency or private company, or in research and design of power and machinery with private company. Age 25. Salary $2400. W-295

AGRICULTURAL ENGINEER (B.S. deg) desires research and development work with private company or land-grant college. Age 45. Salary open. W-296

AGRICULTURAL ENGINEER (B.S. deg) desires sales engineering or maintenance work in farm machinery or farm structures field. Age 26. Salary $3600 to $5500. W-297

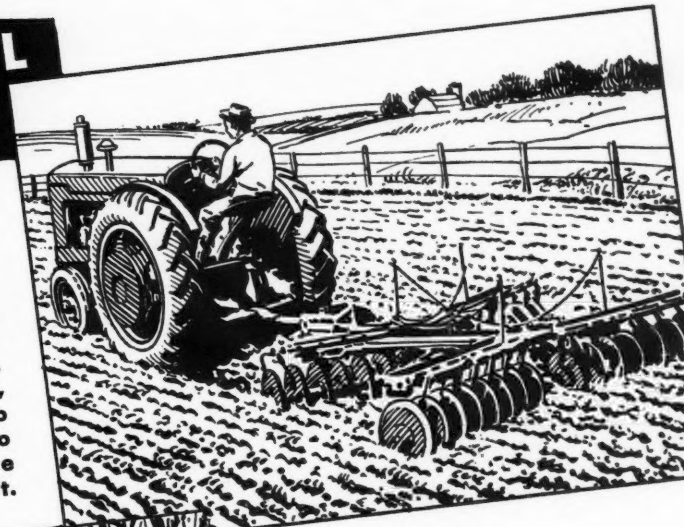
UNDERGRADUATE ENGINEER, with engineering experience, desires sales work in machinery, rural electrification, or farm structures; college work, or research or project engineering work in a government agency. Age 34. Salary open. W-298

AGRICULTURAL ENGINEER (B.S. deg) desires public service research, teaching, or extension work in power and machinery field. Age 26. Salary $2500. W-299

CONTINENTAL ENGINES

Power for the Farm

THE TRACTOR-DRAWN disk and the stump-cutter shown in action below illustrate but two of the hundreds of applications of Continental agricultural engines. Red Seal agricultural engines, in more than 20 models, 5/8 to 180 horsepower, are built to do any farm job better, more reliably, and at lower cost.



GLOBAL demands for American farm products call for bigger crop yields. Machinery-wise farmers know the better their equipment the greater their harvests. They know that when they buy Continental-powered equipment, they buy the finest. Leading manufacturers of quality farm machinery have standardized for years on Continental Red Seal power.

DOUBLE DUTY in the orchard for Continental power. Both tractor and sprayer are contributing to more bountiful yield, because exclusive Continental features give rugged Red Seal Engines the power and stamina necessary for added hours of trouble-free service. Rely on Continental for every power need on farm, plantation or ranch.

POWER BY

Red Seal Engines

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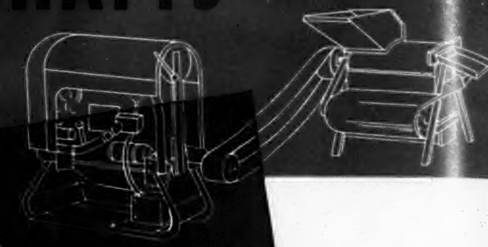
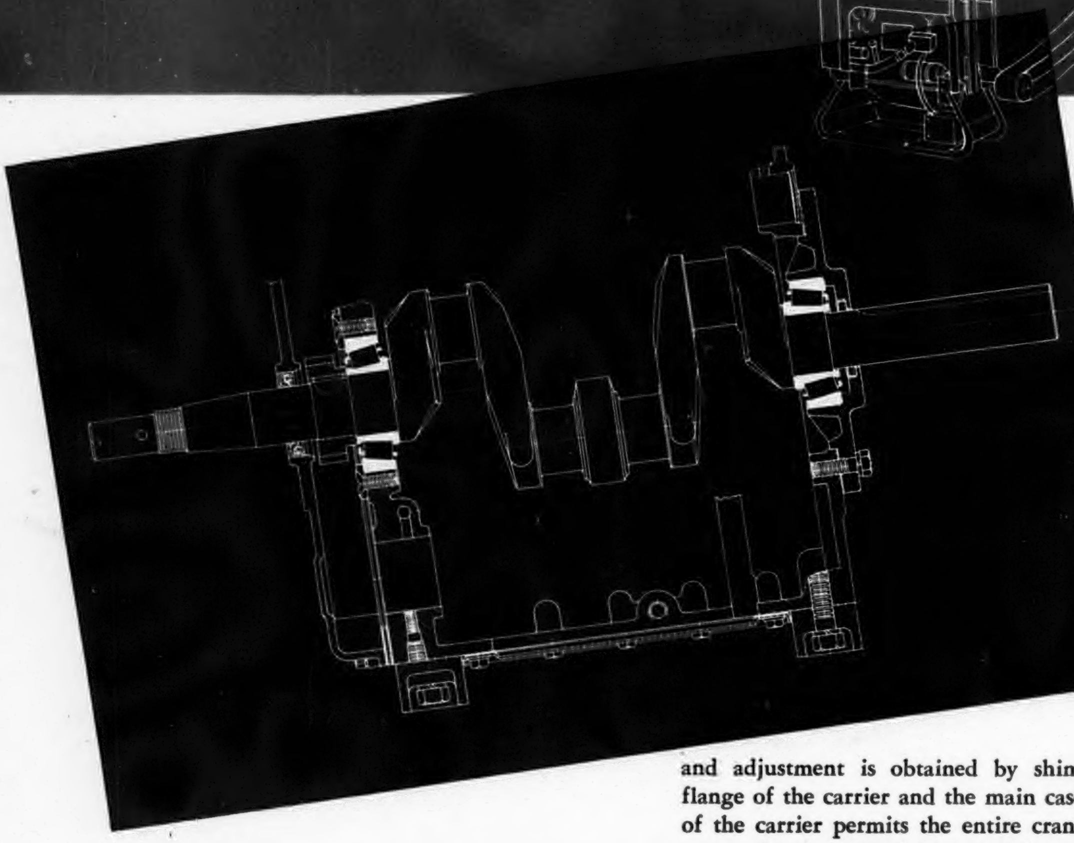
Engineering Tips

ON TIMKEN BEARING MOUNTINGS FOR ENGINE CRANKSHAFTS





"Handy as a pocket in a shirt," aptly describes a small internal combustion engine for farm use. Pumping water, grinding feed or furnishing power for the countless jobs about a farm make one of these units almost indispensable where electric current is not available.

Single or multiple cylinder designs lend themselves particularly well to Timken Bearing applications. The ability to absorb the shock of the explosive charge, carry radial and thrust loads, provide a nicety of adjustment and practically wear-proof qualities are important factors to keep in mind.

In the design illustrated, the left hand bearing is located directly in the case of the engine and backed by a fiat plate fastened to the engine frame by screws. The right hand bearing is mounted in a cup carrier and adjustment is obtained by shims between the flange of the carrier and the main case. The diameter of the carrier permits the entire crankshaft with the cones already pressed into position to be assembled from the right hand side. The right hand cup is also pressed into the carrier before final assembly.

When Timken Bearings are engineered into a machine it not only means improved performance but an easier selling machine as well.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

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